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CO-OPERATION IN SCIENTIFIC RESEARCH IN THE BRITISH EMPIRE

A FEATURE of the discussions at the conference on the Planning of Science arranged by the Association of Scientific Workers last January was the constant reference to the need for closer inter-Allied co-operation, and in particular to the need for extending the arrangements by which young workers from the war laboratories may visit their colleagues in other countries, not merely for discussion but also to work side by side in allied teams. The value of fostering contacts between workers in the universities, in industry, and in Government departments, and of frequent exchange of staff as well as of information, was clearly recognized, and was afterwards reiterated by Dr. P. Dunsheath in a paper before the Royal Society of Arts. Similarly, the importance of establishing a central information bureau from which such scientific and technical liaison could be conducted as to ensure that departmental missions are at least in touch with one another, and that those at the centre know what all, and not just a few, of the various departments are doing, no longer appears to be in dispute.

Specific recommendations have now been made in a report of the British Commonwealth Science Committee set up under the chairmanship of the president of the Royal Society in October 1941 as the outcome of a conference held at the Royal Society's rooms on October 7, 1941. This conference included representatives of the Dominions and India, and of the Royal Society ; and the secretaries of the Medical and Agricultural Research Councils and the secretary of the Department of Scientific and Industrial Research, Lord Hankey and others were invited. The general objectives were to secure scientific co-operation in tackling the emergency problems of the immediate post-war period and to ensure that the most should be made of our common scientific resources after the War for improving both scientific knowledge itself and the life of the peoples of the Empire ; in particular, the conference was to consider means of promoting co-operation between the several parts of the Empire in scientific research and in the application of science to technical, biological, medical and economic problems.

The report now issued summarizes the discussions at the twelve meetings of the Committee. These discussions have been focused mainly on schemes for collecting and disseminating information, for example, on the model of the Imperial Agricultural Bureaux ; schemes for collaboration in research within the Empire ; and schemes for facilitating visits and readier movement of research workers, university teachers and others within the Empire. The extension of such schemes to collaboration with the United States has also been discussed. The Committee has aimed at discovering, so far as possible, what is lacking in the existing machinery, and it stresses that the implications of the Atlantic Charter point inevitably

to the need for closer political, social and technical collaboration with the United States, the U.S.S.R., China and other countries or regions. Planning collaboration in well-defined spheres of activity is a pressing need, first through the establishment of the best agreed co-operative machinery for exchange and dissemination of technical information and later by planning for co-operative research on problems common to all or to certain regions.

As an example of such a regional scheme, the report cites Brigadier B. F. J. Schonland's suggestion that institutes for research on African problems might be formed in such subjects as tropical diseases, social anthropology, native languages, ethnology, geology, geophysics and meteorology. Many important problems of world-wide significance are being investigated independently in Empire countries and elsewhere, and the advantage which would result from co-operation between those countries willing to pool resources for the common good need scarcely be stressed. The Colonial Research Committee recently established under Lord Hailey's chairmanship should facilitate such co-operation, and the researches which may be undertaken by the Committee should also be co-ordinated with work in the Dominions and elsewhere.

It is unnecessary to reiterate here the examples cited in the report of fields in which such co-operation is called for and is related to programmes of post-war reconstruction, or to enumerate the various international organs already in existence, such as the International Locust Research Committee, the World Power Conference, and the International Institute of Agriculture. Proposals for the re-organization of some of these, for example, the International Health Organisation, were already under consideration at the outbreak of the War, and most of these services will need reviewing and probably revising in the most suitable form and on as wide an international basis as possible after the War. For the re-establishment of such co-operation Anglo-American initiative may indeed be essential, and further consideration will have to be given to machinery for close collaboration in research and the establishment of laboratories and institutes common to the Empire and the world.

On this question the report therefore makes three specific recommendations. First, that a suggestion be made to the Governments of the various English-speaking countries that they should consider the possibility of maintaining permanent scientific and technical representation in London and possibly also in other capital cities of the English-speaking world. Secondly, that such scientific and technical representatives of the Dominions and India permanently established in London should, together with official representatives of science in the United Kingdom and the Colonies, be constituted a British Commonwealth Scientific Collaboration Committee, to act with the Royal Society in the discussion of topics of common interest, to keep in touch with all agencies and organizations for the collection and dissemination of scientific information, to further schemes for co-operation in research, and to make such recommendations and proposals for common action as may seem fit. Thirdly, that if scientific and technical representatives of the United States and of other countries outside the British Commonwealth are established in London, arrangements should be made to seek their co-operation, so far as may be practicable and appropriate.

The wisdom of this last recommendation is so patent that the support of all scientific workers is assured. The report itself indicates that the New Zealand Council for Scientific and Industrial Research, the National Research Council of Canada and the National Research Board of South Africa are already prepared to support such collaboration. Scientific workers, however, should demonstrate emphatically their support both through their professional associations, and also in their private capacity as individual citizens, so that the Government can be in no doubt as to the extent of the support which is forthcoming for the proposal. There should be no ground for any pretence that the recommendations are in advance of what scientific workers as a body are prepared to endorse and wholeheartedly to implement.

The first of the six recommendations of the report, however, is one which makes even stronger demands for immediate support and response from scientific workers. There are, as the report points out, a number of bodies collecting and disseminating scientific information which might be assisted if made part of a wider scheme, and in particular, collaboration in the production of scientific abstracts of high quality for the common use of the English-speaking world would have the strong support of the Committee. In accordance with this, the Committee recommends that the Royal Society should invite representatives of the appropriate scientific, technical and official bodies to meet as early as possible this year to discuss in general the further development of abstracting and information services as a co-operative effort between English-speaking countries, and, if agreed, to propose machinery for making a more detailed inquiry and for formulating more definite plans.

The report touches here on a demonstrable weakness in the organization of science. Besides the overlap between *British Chemical and Physiological Abstracts* and *Chemical Abstracts* and *Science Abstracts*, there are numerous examples of overlap and duplication in more limited fields, such as analytical chemistry and particular industries, which are hard to defend to-day against the charge of extravagant use of labour and material. That this is now being more widely appreciated is indicated in an inquiry, sent out almost simultaneously with the publication of this report, to members of the Society of Dyers and Colourists, asking for an indication as to whether or not members would be prepared to dispense with the abstracts which are at present included in the *Journal* of that Society. Further opportunities for rationalization in a comprehensive scheme are clearly to be found in the abstracting services and publications of research associations and similar institutions, although here are to be found one or two examples of the effective elimination of duplicate effort. In the medical and biological sciences the position is much worse, and there are really wide opportunities of eliminating

duplication of effort even within the limits of Great Britain.

There can be little doubt that rationalization in this field will be best secured under some comprehensive scheme covering all the sciences. Such a scheme will have the best chance of dealing with the difficulties in regard to nomenclature, bibliographic detail and the like which are apt to be a source of friction in smaller schemes when co-operation between allied sciences is involved. Moreover, under a large scheme, the savings to be achieved by genuine rationalization should make it unnecessary to continue some of the abbreviation practices to which some abstracting organizations have been forced in recent years owing to lack of resources. Such practices have been a minor source of irritation to many of the present users of such abstracts, and they offer a real obstacle to the wider use of the abstracts in their present form. Again, a central scheme is far better placed to encourage the use of new means for the rapid dissemination of information, such as microfilm, and to explore the possibilities of such developments.

The report shows that the Royal Society's committee is fully alive to the possibilities and to the need for rationalization of effort in the provision of an efficient and widespread information service. By extending, for example, to cover a wider field, the principle of the Imperial Agricultural Bureaux, which are maintained by a central organization, though working in separate institutes, greater financial stability, prevention of duplication and a closer co-ordination of the whole information service should be achieved. Rationalization of existing British organizations throughout the Empire should only be regarded as the first step. Scientific research and technical development have a fundamental bearing on economic factors, and the organization in each country for the collection and correlation of scientific information should be such that it would aid the collection of data by the economic bureaux.

The Committee is clearly right in holding that this whole issue must be the subject of detailed inquiry before any definite proposals are put forward. None the less, while such inquiry is proceeding, scientific workers could do much to prepare the way and to overcome the prejudices and other obstacles which have rendered abortive earlier and more limited efforts in this field. The growing complexity of science and technology, and the penetration of science into almost all human activities, make it essential that every effort should be made to provide as efficient an information service as possible; this is no longer a matter which concerns scientific workers alone.

If rapid progress can scarcely be looked for in the matter of this first recommendation, the situation is entirely different in regard to the last two recommendations of the report. There appears to be no good reason why immediate steps should not be taken to direct the attention of the Governments concerned and of independent agencies to the very great value of frequent and easy personal contacts and exchanges between research workers and students in various countries, which air transport should greatly facilitate in the future. For this purpose, largely increased funds would be required, and some plan for co-ordination would require working out with the various grant-giving bodies.

Similarly, there should be no delay in pointing out to the various Governments, universities and other authorities the advantages which would result from the institution of a system of sabbatical leave, to enable the scientific and technical staffs of academic, Government and industrial research organizations to make fuller use of such facilities as may, from time to time, be available for visits to other parts of the English-speaking world. In the whole of its remarks on this question of the flow of personnel, the report shows that the Committee is fully abreast of the most progressive thought in science and in industry. Here, as elsewhere, the report gives a clear lead to all scientific workers who wish to see science making a fuller contribution both to the war effort and to the task of post-war reconstruction. On them now rests the responsibility of seeing that that lead is followed, and that their existing organizations and societies do all that is possible to secure and support the necessary action required to implement the recommendations.

IMPACT OF SOCIAL INFLUENCES UPON ART

The Psychology of Cultural Change in Painting

By Dr. R. W. Pickford. (British Journal of Psychology, Monograph Supplements, 26.) Pp. vi+62. (Cambridge: At the University Press, 1943.) 8*s*. 6*d*. net.

NO painter can avoid some degree of self-expression; he may introduce a large amount of it, but in any event he is unlikely to be utterly objective. Whatever his choice of subject and treatment, his composition will be psychologically significant. What is perhaps even more important is that he has expended energy in the making of his picture and, through strife and toil, has arrived at something which, by highly complex paths, represents at last a function of his social environment. Thus, in the introduction to his monograph, Dr. R. W. Pickford paves the way for the detailed development of his theme. He is concerned neither with techniques nor with æsthetics; his task is to discuss social influences in their impact upon artists. In so doing, he performs a double service—to the man of science who realizes the profundity of all that is involved in creativeness (in whatever form), and to the historian, who is sometimes curiously reluctant to see in paintings the documents he most may need.

Naturally, this is scarcely a contribution for the layman. It is a closely woven pattern, cautious in the intertwining of warp and woof. However, one criticism the non-initiated might be tempted to make, and it may be worth while to anticipate it now. He would assert, in effect, that all this close analysis only amounts to what anybody with but a modicum of common sense would surmise in less time than that taken to say Jack Robinson. Examples are the effects upon leaders of those whom they lead, of frustration and of thwarted purpose, and so on. But in this he would be mistaken. A superficial interpretation of the nature of genius is usually rash, and

there is a world of difference between riding roughshod over the minutiæ of circumstance inherent in some artistic or intellectual upheaval, and the enviable clarity of exposition, step by step, which is a feature of Dr. Pickford's approach.

A reasonable distinction can assuredly be drawn between a study of groups and individuals on one hand, and the psychology of cultural change on the other. This dichotomy serves well in the present instance, dividing the whole monograph into two approximately equal parts. Furthermore, it is easier for the reader to be introduced to the personalities crossing the stage before being asked to pass judgment upon the setting or settings which in fact contained them. The result is a very human assessment of the whole problem, or, as the author would call it, "comradely". The reviewer wishes, however, that examples from the West somewhat earlier than the French masters could have been discussed; for example, the Italian primitives and the Flemish painters. Certainly group tendencies as well as directional inhibitions were strong in both these movements. The point seems to emerge that it is just as advantageous (to put it mildly) in psychological research to take the simplest case as material upon which to work as it is in the more exact sciences. Of course, it is far from universally true that simpleness—not necessarily simplicity—of technique connotes the simple mind, but it was probably so in, say, Siena in the fourteenth century, thus providing a good springboard from which to attack later complexities.

The analysis of Chardin, Goya, Daumier and Cézanne is most illuminating. Dr. Pickford is thus led to discuss am[illegible]nce, the characteristic possessed by some people o[illegible]playing acceptance and rejection of the same situa[illegible] either alternately or simultaneously. Apparently this did not afflict the first two of these artists, but was strong in Daumier and terrific in Cézanne. When present, it is clear that severe mental conflicts will arise. It is significant how similar in some ways these dispositions are to the transitional properties frequently observed in physics and chemistry. The parallel must not, however, be pressed too far, for whereas we have recently learnt (for example, in crystallography) how to insert missing members into a series, if Nature is not kind enough to provide them, we cannot yet do this for human material. Until we can, our results will often be patchy, though with the vast amount of 'stuff' available, it is presumably worth combing very thoroughly in attempts to fill the gaps.

The Barbizon painters represent a small nexus of men, compact and bourgeois, very susceptible to natural scenery and to the appeal of tranquillity. Whence comes this latter characteristic? It is hard to say, but perhaps permissible to mention that such a totally different person as John Keble was writing of the 'soothing' element at very closely the same moment in the first edition of his "Christian Year". Corot appears as the undisputed leader of the group. He possessed qualities amounting to greatness, both as a painter and as a man. Millet, who always enjoyed considerable popularity in Great Britain, was obviously influenced by the Italian primitives. Both for the Barbizons, and for the Pre-Raphaelites (to be discussed later), it seems that a forceful literary critic was needed to make the work of psychological groups fully effective. This was achieved for the former by Thoré, and for the latter by Ruskin. At this distance of time, it is easy to underrate how much these two writers did for their causes. Another condition for effectiveness is the presence—in some form or another—of interpreters, who, as Dr. Pickford remarks, resemble stepping-stones to conduct the public to the great masters themselves. This was done admirably by the lesser lights of the Barbizon school.

Perhaps it is as well to recollect what a very specialized study this cultural change in painting is. Unlike other means of approach, it is competent to offer suggestions for an evaluation of kindred problems by comparative methods. To-day, for example, we are being pressed for an enhanced publicity campaign in the interests of science. It is hard to avoid the conclusion that history is but repeating itself. Once again the question is: "How can they hear without a preacher?" Stepping-stones of one kind or another will apparently always be needed if the creativeness of supreme minds is not to become sterile, and their contributions unheeded. What the Barbizon group in particular has to teach is that this widening of influence is possible without disturbance of genius at the top. But the balance is a delicate one. Corot was a great enough personality to appreciate the necessity for diffusion, but to maintain inviolate the fountain-head.

We are thus invited to examine the Barbizon's group structure. A most intriguing short paragraph on p. 14 almost implies—though it does not exactly say so—that its character was that of a *Gestalt*. Admirers of Wertheimer will be quick to notice a parallel between Dr. Pickford's pattern of these men and his "celestial orchestra" in which, as Koffka remarks, little would be gained by restricting attention to the part played by each angel. Important, indeed essential, as every performer is, the meaning of the work resides in its 'wholeness', that is, in its *Gestalt* character. That this is, broadly, the direction of thought seems probable from a remark (p. 46) on stable configurations, and their part in conservation. Clearly, there is something akin to Le Chatelier's principle in physical chemistry in operation here.

Rousseau's personality—as a "Barbizon", and as an individual—is of great interest. He was given to excessive repainting of detail. In acting thus, he expends much labour without reducing the free-energy of his picture appreciably: for a given organization he may even deviate from the minimum, thus increasing the 'potential' and diminishing his approach to satisfaction and repose. So far as the present reviewer is aware, a Rousseau has never been X-rayed. Occasionally, by these means, objective proof is obtained of the way in which artists—not infrequently with disastrous results—have modified and remodified details.

We now approach a major development, the advent of the Pre-Raphaelite Brotherhood. Because its activities ultimately degenerated into being 'just too arty-crafty', it is an error to overlook its originally serious purpose. Dr. Pickford has handled this very tangled skein of dispositions and emotions with distinction. Perhaps it is profitless in the present essay to enlarge upon his careful analysis of the leading personalities involved: they were all more or less abnormal, and some of them exceedingly 'difficult'. What is important is the undoubted influence which the whole affair had upon society, and society upon it. Religion, social reform, æsthetics, intellectualism, and even manners were engulfed in the flood generated by Rossetti and his followers. A pathetic figure, somewhat on the periphery, was Swinburne, inter-

grated for us largely on Freudian principles. For him, however, and for others like him (if such there ever were), the most lethargic of streams will always find sanctuary at last in the wide ocean spaces. Incidentally, it would have been interesting to know the author's views upon the work and life of Lord Leighton. Too late, and perhaps ill-suited, for full-blooded participation in Pre-Raphaelism, his art is clearly conditioned by it in a very complex and obscure way. His place in the contemporary world of affairs made him and his compositions a 'derived function' of some consequence. It has little to do with stylistic questions, being mainly a matter of social environment.

Chapters 5 and 6 take us far afield, to the contemplation of the Mogul miniatures, and of Russian painting, respectively. The psychological types encountered are so entirely different from those met with in the West that the reader experiences a sharp discontinuity at this point. It would be a pity if he thus inclined to follow his guide less closely here: for the sake, however, of avoiding too wide a sweep, it is proposed now to pass on immediately to the second main portion of Dr. Pickford's theme, namely, the psychology of cultural change itself. In this section the Eastern factors have their full part to play, and with increasing knowledge of them it should be possible to discern their great importance in the transmission of cultures.

Three distinctions are made in this process. First, then, is the passing-on of culture from one large group to another, with fairly permanent contact. Secondly, comes borrowing, that is, the impregnation of a large group by a small one bringing its cultural limits with it. Thirdly, appears grafting, which is a special case of borrowing, when there is an element of force on the part of the transmitting agents.

Contact transmission is, on the whole, the most primitive method, as exemplified by the Bushmen of South Africa. When civilization is more advanced, borrowing and grafting are more likely to occur. A good example of the former is the way in which English landscape influenced the French masters immediately before the Barbizon school. It is well, however, to avoid the conclusion that borrowing alone will suffice to set a cultural change in motion: a more profound impulse such as social constructiveness is probably essential. In this way, borrowing is somewhat catalytic; experience shows that, as in chemistry, the catalyst may become poisoned, and the reaction comes to a stop.

A question discussed at length is that of omission. It seems that there is continuously at work a kind of mental sieve through which new ideas (of all shades of value) are constrained to pass. In this process, many will be filtered out. This sieve-action is much more complex than a mere mechanical selection, and two persons, starting alike but with unequal 'meshes', will embark upon their respective future enterprises on entirely different lines. The psychology of what is thus rejected—and, therefore, of what is left—is of great interest. There are various possibilities. One is that group tendencies rather than individual ones will predominate. Mogul painting illustrates this, and the same is true to some extent of the history of the Russian ikon. An example of personal omission, on the other hand, is that of Rossetti, who at once had no use for the mystical and poetical ideas about Dante which characterized his father.

The author makes an illuminating comment upon the decay to which, in general, cultures are subject. Decline he believes to be but "the result of very great adversity to construction".

In a review of reasonable length, it has only been feasible to notice a small proportion of the points made by Dr. Pickford. There are many others which will stimulate thought and inquiry from all the diverse interests concerned. What stands out above them all is the insistence upon meaning or significance in painting, as illustrated by cultural change. This transcends mere explanation, and is thus in harmony with modern thought in other directions. It is very much to the good that this movement should gain impetus in one of the most highly developed of the fine arts. The author has produced a scholarly design, seen to advantage against a background at once warm and magnanimous. F. IAN G. RAWLINS.

COPERNICUS

Nicholas Copernicus (Mikołaj Kopernik), 1473–1543

Prepared by Dr. Józef Rudnicki. Translated from the Polish by B. W. A. Massey. Pp. viii+53+25 plates. (London: Copernicus Quatercentenary Celebration Committee, 1943.) 10s. net.

THE work of Copernicus, whose centenary we have been commemorating, was not limited to astronomy, though to most people he is known only by his astronomical work. The publication under notice surveys briefly his activities. He possessed some artistic skill, and among his manuscript remains is one showing that he dabbled in poetry. This is a religious narrative poem, "Septem sidera", describing the life of Christ up to the time of his converse with the teachers in the Temple. He obtained proficiency in languages also, and published a translation from Greek into Latin of the poems of Theophylactus Simocatta. His work on economics was of considerable importance, and it should be remembered that he formulated Gresham's Law, that bad money, if recognized as legal tender, will drive out good. He also showed the necessity for the ratio of value between gold and silver coins to depend on that between the metals. During the hostilities with the Teutonic Knights in 1521, when he was administrator of the capitulary estates at Olsztyn, he was the only one of the canons who remained at his post, and later the king rewarded him with the title of "Commissary of Warmia" for his work.

All these and other activities besides seem insignificant now in comparison with his revolutionary work in astronomy, which exercised a profound influence in human thought. Perhaps his name would have been almost unknown in history and his *magnum opus* have rested forgotten on the shelves of a monastery library if it had not been for the influence of Rheticus, a young mathematician from Wittenberg. He procured the publication of Chapters 12–14 of "De Revolutionibus", which were included in Copernicus's "Trigonometry", and the issue of the whole work seemed an attractive financial proposition to J. Petreius, the Nuremberg bookseller. As, however, the book appeared very revolutionary in character, a piece of fraud was perpetrated by Andrew Ossiander, the editor, who was a Lutheran preacher interested in astronomy. He replaced Copernicus's original preface, unknown to Copernicus, by an anonymous one of his own, and in this the conclusions of the work were presented as mere

hypotheses, without any basis in reality. Unfortunately, a widespread belief that Copernicus had advanced his theory merely as a mathematical device prevailed as a result of this forgery, and Copernicus did not live to correct the error.

The general acceptance of the heliocentric theory was retarded for various reasons. It was claimed that an astronomical system would fit in equally well with observed phenomena if a geocentric view were adopted. Then certain implications of the new theory seemed contrary to the doctrine of the Church, which was prepared to enforce its own views by severe methods, as shown by the fate of Bruno and Galileo. Finally, after the Swedish forces of Gustavus Adolphus had occupied Polish Prussia and Warmia in 1626, Copernicus's books and various documents relating to his life were carried off to Stockholm and Uppsala. There they remained forgotten until the Polish scholar Birkenmajer rediscovered them about the beginning of the present century. In spite of these obstacles the truths first propounded by Copernicus paved the way for those great and far-reaching discoveries which were accomplished by his successors.

THE LIFE-HISTORY OF A PUEBLO INDIAN

Sun Chief

The Autobiography of a Hopi Indian. Edited by Leo W. Simmons. (Published for the Institute of Human Relations.) Pp. xi+460+5 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1942.) 26s. 6d. net.

THIS book—the story of a Hopi Indian from Arizona—forms an interesting sequel to its predecessor in the same series, which was a similar account of a Kwakiutl Indian from Vancouver Island. In both cases the period covered is one of conflicting cultures—Indian and white—beginning whilst the Indian customs are still holding sway but gradually weakening as the white influence becomes stronger. The cultural setting of the two tribes is quite different, and a good deal of interest is added if both autobiographies are studied.

Don C. Talayesva, the subject of this study, was born in 1890 at Oraibi, a Pueblo village perched on a 6,500-ft. plateau, in constant occupation by the Hopi for at least eight hundred years. In spite of outside influence the Hopi retained their own individuality, both cultural and racial, longer than many other tribes, and therefore provided good material for investigation. Living as they do in a sandy and arid region, water has always been a problem and many of their ceremonies are concerned with making rain and ensuring good harvests, for upon these the Hopi depend for their living. They are a peace-loving, hard-working tribe, but when attacked they defended their mesa-top fiercely and successfully. Conditions of life made transport a never-ending labour, as all food and fuel and most of the water had to be hauled to the mesa top, and all able-bodied members of the tribe took their turn at this task. There is no supreme chief of the Hopi, each Pueblo is independent and the authority, mainly theocratic, is invested in a council of hereditary clan chiefs. Each Pueblo is also organized into exogamous matrilineal clans and every male is a member of a Kiva group, which is a ceremonial organization.

The background, therefore, of Don's life was of an assured and well-defined pattern, and it is all the more interesting to see the results of the impact on him of white culture. For the first ten years he lived with his tribe and the book gives his own detailed and extremely interesting account of a boy's life from his birth. Very notable is the link between him and his maternal grandfather, who took great pains with his education, both material and spiritual. This fine old man roused the boy before sunrise to bathe and exercise and do useful work for, as he used to say, "Work means life".

According to his own account Don was a high-spirited and mischievous boy for whom ordinary discipline seemed useless. Accordingly his initiation at nine years of age was made extra severe, and the double whipping he received seemed to have a salutary effect. Next year he went to the reservation school to begin his education, which continued until he was eighteen. By this time, as he says, he had learned to "talk like a gentleman, read, write and cipher", work at various trades and "get along with white men". During his last year at school he had a serious illness which he attributes to Hopi witchcraft and during which, as he still maintains, he died and went to the Hopi spirit world in the west. Here he was cautioned by his guardian spirit and allowed to return to life on condition he behaved well in future.

On his return to Hopiland Don renounced his superficial Christian beliefs and resumed his Indian status, taking part in the rituals and ceremonies and marrying a Hopi girl from a suitable clan. He was still troubled by witchcraft, however, and had various illnesses which he attributed to it, as also the loss of each of his children in babyhood. This last was a bitter blow, as Don was passionately fond of children and felt very deeply the stigma of being childless. When he had almost given up his hope for a child his wife's sister brought her two-year-old son, who was very ill and whom Don nursed back to health and then adopted, treating him very well, if somewhat indulgently. But the upbringing of this boy was far less rigorous than was that of Don himself forty years previously, and one wonders how far the clash of cultures will affect this new generation.

The autobiography is written for the most part in Don's own words, edited by Leo W. Simmons, who stayed in Orabi with Don and became his blood brother. The original document has been much shortened, but is even so almost wearisomely prolonged; the author mentions that Don's sometimes monotonous accounts of his meals had to be cut down, and one wonders if the constant harping on the gratification of his sexual appetite might not have been similarly treated. The description of the ceremonies is intensely interesting, more especially so as Don believed in them so wholeheartedly and constantly refused to relate anything that was considered secret. In fact, this refusal almost led to his breaking off his narrative, and he was only persuaded to continue by being shown accounts of the ceremonies that were already printed.

The book is divided into three main parts: an introduction which outlines the scheme of procedure and then gives a general account of Hopi life in Orabi. The main portion is, naturally, Don's autobiography, the scope of which is outlined above; whilst in the appendix are an example of situational analysis, some Hopi myths and legends, a guide to kinship, and samples of Don's compositions. There are a few illustrations, and a comprehensive index gives a finish to a valuable if rather lengthy volume.

K. RISHBETH.

Plain Words

A Guide to Sex Education. By W. J. Thomas. Pp. 84+10 plates. (Sydney: F. H. Johnston Publishing Co., 1942.) 2*s*. 6*d*.

THIS little book is unfortunately mistitled. Unfortunately, because although it scarcely begins to consider the many difficult and thorny problems of sex education, it does give an excellent outline of the physiological facts of sex and some of their sociological implications. Particularly good for such a modest publication are the ten plates, although they are open to criticism on points of detail.

In the first chapter, on "Sex and Wartime Morality", several important questions are begged. It seems to be assumed, for example, that sexual intercourse in marriage implies love and affection, while outside marriage it is "without love" and therefore "an abomination". This attitude neglects the very vital distinction between extra-marital intercourse which is simply promiscuous, and that which is (as is often the case) based on devotion deep and lasting. Similarly the excellent case against the new eroticism of Nazi Germany is weakened by the citing of such 'evidence' as that "Every popular magazine contains at least two or three nude photographs".

Other criticisms of a like nature may be made, and in particular, the author's discursive and repetitive style is rather irritating. But none of this should be taken to condemn the book. It is excellent in its way, and should be as useful in Great Britain as it no doubt will be in Australia.

CYRIL BIBBY.

German for the Scientist (Chemist and Physicist)

By Peter F. Wiener. Pp. xvi+208. (London: G. Bell and Sons, Ltd., 1943.) 6*s*. net.

THIS book is intended to enable the science student to acquire a reading knowledge of scientific German in a short time. The essentials of grammar and a basic vocabulary are built around a Hans Andersen story. The bulk of the volume consists of passages for translation, and the author has evidently been at some pains to select material which has scientific interest as well as a bearing on the development of his theme. A person with a little previous knowledge of German will find the reading of this book an excellent means of brushing up grammar and rapidly acquiring the ability to make sense of scientific literature. A complete beginner might find himself in some difficulty without a little outside assistance.

The reader is not pampered by vocabularies in the midst of the German text. The passages are from works on chemistry and physics, but this need not dissuade the student of other subjects, for the material is general and the vocabulary widely applicable. Literal translations of the German passages are appended, and there is a full vocabulary.

Papers of a Pioneer

Sir Pendrill Varrier-Jones. Collected by Peter Fraser. Pp. 107. (London, New York and Melbourne: Hutchinson and Co. (Publishers), Ltd., 1943.) 6*s*. net.

VARRIER-JONES contributed to various medical journals, reviews and periodicals, a number of lectures, addresses and papers treating of many aspects of tuberculosis. The substance of these has been gathered by Mr. Peter Fraser into a connected narrative.

In the first chapter Varrier-Jones points out that the consumptive's life is a damaged one and that breakdowns and relapses will often occur if he is merely given a course of sanatorium treatment. Frequently, too, the patient remains a source of infection to the community. In the three succeeding chapters the author notes how economic considerations prevent the diagnosis of the early case, that for no class of the disabled is a life "sheltered and yet active, protected and yet self-respecting", so necessary as for the tuberculous, and that the problem is not purely medical. Psychology and sociology are mingled with medical considerations. The remaining chapters of the book describe how the author solved the problem by providing medical supervision, treatment and care in the village settlement at Papworth.

The editor has done his task well. The book will appeal to all workers engaged in combating the ravages of tuberculosis. As Lord Horder remarks in his foreword, there could not be a more sincere memorial to Varrier-Jones and his work.

Changes in the Knee Joint at Various Ages

With Particular Reference to the Nature and Development of Degenerative Joint Disease. By Prof. Granville A. Bennett, Dr. Hans Waine and Prof. Walter Bauer. Pp. ix+97+31 plates. (New York: The Commonwealth Fund; London: Oxford University Press, 1942.) 14*s*. net.

THIS volume summarizes the results of an investigation into the morphological and histological appearances in the so-called normal knee joint at each decade of life. The anatomical changes are described and illustrated in a very fine selection of photographs. Beyond the second decade, all the joints examined showed changes similar to those found in hypertrophic (osteo-) arthritis. The signs of disease were progressively greater with increase in age. Pathogenesis and etiology of degenerative arthritis are fully considered. The authors conclude that the joint changes they describe are essentially due to a degenerative process of hyaline cartilage, and suggest investigation of the factors governing maturation, maintenance and ageing of the hyaline cartilage.

Apart from the scientific value of the accurate observations and the full review of the literature, this book can be recommended to the clinician as a useful reference on prognosis and treatment in arthritis.

Principles and Practice of Chromatography

By Prof. L. Zechmeister and Dr. L. Cholnoky. Translated from the second and enlarged German edition by A. L. Bacharach and F. A. Robinson. Second impression (corrected and with Supplementary Bibliography). Pp. xv+378. (London: Chapman and Hall, Ltd., 1943.) 25*s*. net.

THE early need for a second impression of this useful translation has raised the difficult problem of keeping the work up to date under wartime conditions. Apart from minor corrections the main text is unaltered, but there is a classified supplementary bibliography containing some three hundred references to work published between 1938 and 1941. This makes the work as complete as can be expected at the present time.

SCIENCE IN SOUTH-WEST CHINA

II. THE BIOLOGICAL AND SOCIAL SCIENCES

By DR. JOSEPH NEEDHAM, F.R.S.
British Council Cultural Scientific Mission in China

IN the previous article (July 3, p. 9) some account was given of the work being done in the physico-chemical sciences by our Chinese colleagues under the difficult conditions in this part of Free China.

Exactly how difficult the conditions are is not easy to describe. The students live in badly overcrowded dormitories, and are severely subject to disease such as tuberculosis. Affections such as trachoma, caused by inadequate washing facilities, etc., are common. But the contrast between the life of the normal scientific worker as lived previously and as lived to-day is even more pronounced. Scientific men and women of great attainments are accommodated in rickety old structures around courtyards that cannot be kept clean. The scale of pay has risen only seven times while the cost of living in Yunnan has risen 103 times. I can only compare it with going to live in shellings on the coast of Argyllshire on less than £70 a year after having held a post at £1,000 a year with a good flat. It is often hard for men whose names are well known in Europe and America to get enough to eat. How many of us would have been willing to live in such exile rather than under the invader's domination in comparative comfort?

National Southwestern United University

I turn now to some of the biological work proceeding in and around Kunming. First, in the National Southwestern United University there is a good deal of botany going on under Prof. Ch'ang Ching-Yueh. Cytology is represented by Dr. Wu Su-Hsuen (she was trained at Ann Arbor, Michigan), and plant physiology by Dr. Li Chi-Tong, who is making interesting studies on the cleistogamy of the violet plant. There is a nutritional laboratory under the energetic Dr. Shen Tung, where a new and exceedingly rich source of vitamin C has just been discovered—perhaps the richest known—*Emblica officinalis* ("i-gan"), often described as the Chinese olive, but really belonging to the Euphorbiaceæ. In entomology, under Lin Chung-Lo and Lu Chin-Rjêng, much work is going on on the lac insect, an animal of much economic importance to China. Similarly, a complete key to the caterpillars of Yunnan is nearly ready, with special reference to the pests. A complete key to the Yunnan flora, mostly the work of the late Prof. Wu Yuen-Chen, who died last year from hardships encountered here and from inadequate hospital equipment, is now being prepared for the press by Dr. Chien Cho-Po.

Chinghua Institutes of General Physiology and Plant Pathology

Out at Dragon King Pool there are the Chinghua Institutes of General Physiology and Plant Pathology. The former is under the leadership of Dr. T'ang P'ei-Sung, very well known in America, especially at Chicago and Woods Hole, as a collaborator of Dr. R. W. Gerard. Dr. T'ang's flair for originality and ability in younger men has gathered round him, besides Shen Tung, such men as Dr. Yin Hung-Chang, an expert on plant growth hormones from the California Institute of Technology, and Dr. Lou Ch'êng-Hou, a biophysicist who is studying electric responses of plants. It was a remarkable thing to see a complete laboratory for the assay of plant growth substances in these primitive conditions. Dr. T'ang's group is also interested in the mechanisms of subterranean fruiting in the peanut, *Arachis hypogæa*, a subject again of economic importance for China. They have made an extensive series of studies, too, on the metabolism and physiology of the silkworm, on the streaming of plant protoplasm, and on the production of polyploids. Stimulated by the practical problems confronting Chinese science, Dr. T'ang has written a book of essays, which it is hoped may be published either in England or America.

The other Chinghua Institute, that of Plant Pathology, is presided over by Dr. Tai Fang-Lan. Here all kinds of interesting things also are going on. Taxonomy of mushrooms (Chiu Wei-Fan); nematode carriers of wheat blight (Yu Ta-Fu); genetics of resistance to bean wilt and wheat rust (Fang Chung-Ta); morphology of aquatic fungi (Shen Shan-Chong); and an extraordinary system of symbiosis or cross-stimulus between certain termites and a certain fungus (Chou Chia-Chih).

The number of papers in manuscript which this Institute and others have accumulated in the past two years is considerable. The fact that scientific papers cannot be adequately printed in China, and the fact that the ordinary mails, owing to censorship and other difficulties, are not such as to encourage scientific men to entrust their manuscripts to them, constitute a menace to the morale of our Chinese colleagues. It is therefore the policy of the British Scientific Mission to facilitate the passage of meritorious papers to Britain and America, for publication in our own scientific journals, until those of China can be got on their feet again.

Drug Research Institute

Not far from the Chinghua institutes, in the same part of the country, is the Drug Research Institute of the Ministry of Education, directed by Dr. Ch'ing Li-Pin. Here special attention is devoted to the botany and pharmaceutics of the indigenous Chinese drugs. This Institute is housed in an old village Buddhist temple, in the main hall of which a gigantic Kuan-Yin image looks down approvingly at the indexed collections of dried plants, the numerous editions of the "Pên Tsao" (the classical Chinese pharmacopœia), and the small printing-press on which a bulletin containing descriptions of new plant species is prepared, and some numbers of which have already been sent to Kew.

Dr. Ch'ing Li-Pin is also the director of the physiological section of the Peiping Academy, together with the zoological section (director, Dr. Chang Hsi), on the shores of the great lake in the Kunming plain. The latter possesses a good working library. Investigations on the plankton of the lake are proceeding (Liu Yung-Pin), on the diseases of the edible fishes of the lake, and on the mollusc Margaria, an edible viviparous gastropod which is very abundant in this region.

National Epidemics Prevention Bureau

In another part of the Kunming area is the National Epidemics Prevention Bureau, under the directorship of one of China's most able bacteriologists, Dr. T'ang Fei-Fên, assisted by Dr. Wang Yo-Wei and a large staff. Here last year five million doses of typhoid inoculation were produced. The Institute

also makes smallpox lymph, diphtheria and tetanus toxoid, and a good many other things, including diagnostic antigens such as the Widal test serum for typhus, and the Kahn antigen for syphilis. Preparations are under way for producing typhus vaccine. Dr. T'ang is well known to bacteriologists, immunologists and tropical disease specialists in England and America. His plant maintains high standards of cleanliness in the stables and animal houses in spite of the lack of any running water supply, and an extremely efficient system in the growing, bottling and testing departments. Particularly interesting is the fact that the plant includes a complete glass factory, where neutral glass is made from the proximate ingredients and worked into ampoules and capillaries. The glassworks also produce flasks of all shapes, tubing, condensers, beakers, etc. The story of the plant is an epic in itself. For many months the only available boiler was one which was leaky and unsafe, requiring repairs every evening after use, and with this all the sterilizing apparatus, distilled water supply, etc., had to be run; fortunately no accident took place. Typical of the Institute's pertinacity is the re-utilization of agar by a method specially devised. Dialysis took place from a raft in the lake until the depredations of fishes became too great, and a dialysis tank had to be rigged up on land out of the very few materials available. When commercial supplies of proteolytic enzymes ran out, a hog colony was started, and when the condition of the beasts became such as to yield but poor pepsin, the hogs were fattened by special feeding. This, however, is extremely costly, as indeed is the feeding of all the animals, which has reduced the number of horses, for example, considerably. The Institute is now supplying sera for other United Nations troops as well as Chinese, in the East.

National Provincial University of Yunnan

Within the city of Kunming itself is the National Provincial University of Yunnan, occupying a beautiful site and some of the antique buildings of the old Imperial Examination Halls. It has suffered heavily by bombing, having lost its whole chemistry building. Most of the staff are French-speaking, owing to the former French cultural influence in Yunnan. Thus Prof. Chao Yin-Lai, the organic chemist, is a former collaborator of Prof. Grignard. The courses in the medical school, small but neat, are still all in French. The president, Dr. Hsiung Ch'ing-Lai, is an able mathematician, also French-speaking. Among the heads of departments, however, is Mrs. Tsui Chi-Lan, a morphologist who had her training in Germany. She is now occupied with detailed anatomical studies on the origin of the olfactory organs in Amphibia, preliminary to experimental work on the same subject. She is a pupil of Kraus, Spemann and Hartmann.

The University of Yunnan is at present quite strong in the social sciences, having on its staff Dr. Wang Kan-Yu (a pupil of Prof. Ernest Barker) and especially Dr. Fei Hsiao-Tung, widely known as one of Prof. B. Malinowski's most brilliant students, and for his book on village life in China. Dr. Fei's institute is the Yunnan-Yenching Institute of Sociological and Anthropological Research. It is situated in a small town some hours away from Kunming, occupying rather unusual quarters, namely, a fine old tower or pagoda, dedicated to K'uei-Ko (the god of literature), and placed there because one of the townspeople long ago attained to the dignity of being a Hanlin scholar. The top floor, which contains the image of the god, houses part of the library, and the floor below is the main working-room. The Institute has recently published a number of valuable monographs. Dr. Hsu Lang-Kuang, Dr. Fei's chief colleague, has written on the introduction of modern medicine into a primitive community on the western borders of China, a study which necessitated close observation by him of a cholera epidemic. Like old Nicholas Culpepper in Kipling's story, "A Doctor of Medicine", it seems that the people carry out a number of hygienic measures for quite wrong theoretical reasons, but at the same time have recourse to Taoist and other magic. Other colleagues have written on labour conditions in Yunnan, and on the different types of rural economy in the province.

Chinghua Institute of Statistics and Census Research

In a different part of the same town, there is another of the Chinghua institutes, that of Statistics and Census Research. Headed by Dr. Chen Ta, ably assisted by Dr. Tai Shih-Kuang, this institute carries out experimental censuses of selected regions, observing the reactions of the peasants, checking up on various sources of error, and seeing how best to accustom the Chinese country people to a process which must in due course take place. The Institute is housed in a Confucian temple. An imposing succession of 'pailous' and gates leads into the main court, with its raised platform shaded by a few tall old pine-trees. Within the shrine, in true Confucian puritanism, there is only the golden tablet of the sage, surrounded by those of his disciples, among which those of Mencius and Chu Hsi can be distinguished. Below are the calculating machines and card indexes of the statisticians. It is felt that Confucius would be very pleased to see his house so used in the service of the teeming people of whom he said "First feed them, then educate them".

Confucius, like so many of us to-day, was concerned with problems of government. The proper relation of science to government is a problem which has scarcely yet been solved in Britain or America, still less, therefore, has it been solved in China. At a first glance, it seems that in China there is not yet a sufficiently intimate relation between the university men of science and the growing industries. There is also perhaps a tendency to over-emphasize applied science in the short-term sense at the expense of pure science, especially in the training of students and the sending of them abroad. The scientific man is ordinarily ignored or treated as academic and unpractical; but on occasions is expected to produce practical results without delay by those who have turned a deaf ear to his requests for adequate material support and essential research supplies. The advantage of his advice within the Government organizations themselves is also not fully appreciated.

In these two articles it has been impossible to do more than run over some of the salient features of Chinese science in the far south-west. The main impression which remains with the visitor to the scientific institutions of this vitally important province is of the quite indomitable perseverance and courage which the Chinese scientific workers have shown in carrying on in the remote parts of their country, and of the extraordinary cheerfulness and even gaiety which they show in the midst of their adversity.

STRUCTURE OF α-KERATIN

By DR. IAN MACARTHUR*

Textile Physics Laboratory, University of Leeds

THE structure of the keratins is of interest alike to wool technologists and protein structure analysts. Interpretation, by Astbury and his colleagues[1–4], of the essential features of these fibres in terms of the shape and interlinking of polypeptide chains has earned increasing recognition. The results, achieved from relatively simple X-ray data determined under controlled conditions and used in conjunction with other physico-chemical findings, together with general advances in our knowledge of macromolecular systems, demanded an extension to more intensive X-ray methods. Accordingly, with the support of the International Wool Secretariat, an investigation in progress for some time in the Textile Physics Laboratory, University of Leeds, has aimed at improved range and definition in keratin fibre X-radiograms, with the final objective of a complete analysis of the more crystalline material. Some longer spacings[5–7] were already available, and some preliminary findings have been reported[8]. Analysis is still in its earlier stages, but in view of the interest attaching to very recent work[9,10] with which the present investigation is bound up, a factual publication is not premature.

Technically, use has been made of chromium, iron and copper $K\alpha$ radiation, low-dispersion beams defined by precision ribbon and bore collimators, vacuum cameras, longer-distance photographs, and to some extent monochromatic radiation. The necessarily long exposures have been reduced to reasonable limits by the use of a high-power rotating-anode X-ray generator[11]. Keratin types examined include horn, horsehair, mohair, wool, and especially porcupine quill.

The sharpest and most complete fibre pattern is given by the cortex of African porcupine quill tip (Fig. 1); definition and orientation are poorest for horn. The fibre photograph varies somewhat with the keratin type, at least in completeness, degree of orientation, resolution, and probably also in relative intensities; but the main structure and reflexions are similar. Different specimens of a given type show variations in crystallinity and (slightly) in lattice spacings; while for a given specimen there are variations also with treatment and conditions (humidity, tension, pressure, etc.). The quill photograph will be considered typical for the keratin series.

Fig. 1. FIBRE X-RADIOGRAM OF AFRICAN PORCUPINE QUILL TIP. PLANE PLATE; *R*, 9·8 CM.; COPPER $K\alpha$ RAYS; DRIED, P_4O_{10} + VACUUM; COLLIMATOR, 13 CM. × 0·025 CM.

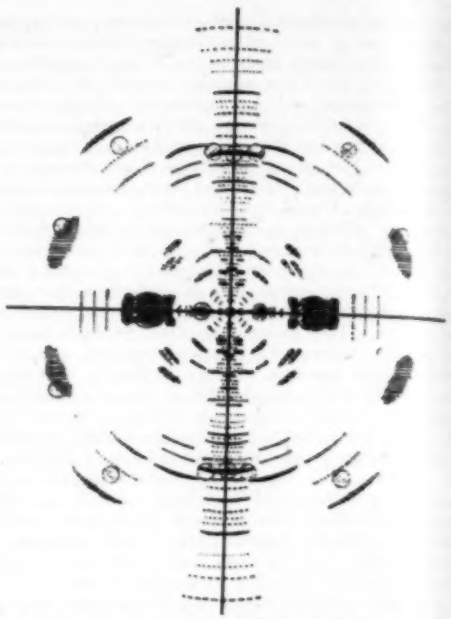

FIG. 2. COMPOSITE CHART OF α-KERATIN DIFFRACTION PATTERN GIVEN BY PORCUPINE QUILL. FIBRE AXIS VERTICAL; PLANE PLATE. (TO *D* 3A.)

For quill, more than a hundred reflexions have now been secured in the range 1–150 A.; as shown by their interrelation and proportionate response to physical conditions, these refer to the same structure. The rich spectrum invites comparison with that of feather keratin[12]. Fig. 2 is a composite diagram showing the α-keratin diffraction pattern for dry porcupine quill tip, down to 3 A. spacings; the circles are the original reflexion areas noted for animal hairs by Astbury and Street[1].

The reflexions differ in quality. The extensive meridian and near-meridian series with the dominant line at 5·14 A. are sharp spots or arcs; they characterize regularity along the fibre axis. The equatorials refer to lateral arrangement and include both sharp and diffuse reflexions, the latter at least in part due to lack of resolution. Their main groups are strong and sharp long spacings (for example, 81, 41 A. at room humidity) and the strong area at ~ 9·8 A. This latter is now considerably resolved, showing a fine structure parallel both to meridian and equator, and containing possibly twenty discrete reflexions. The strongest components occur at 9·2 and 10·5 A., the mean, 9·85 A., giving Astbury's side-chain spacing. In the dry specimen non-axial reflexions are poorly defined; but the importance and location of structural water content in keratin are shown in the way the non-axials resolve and sharpen, even

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with moderately disperse beams, at definite humidities; meridians are practically unchanged.

Stretching beyond a fibre extension of 10 per cent is difficult to realize with the highly crystalline quill tip; but in this range the α-structure, in addition to progressive destruction, undergoes an easily followed reversible 2 per cent expansion fibre-axially and an apparent slight reduction in cross-section. Greater fibre extensions yield the β-pattern without superstructural long spacings. Release of the β-form in water regenerates the α-pattern, now much weaker in meridian fine detail, but sharper and fuller in equatorial resolutions; a similar but less marked change occurs also in traversing the 2 per cent cell-extension range of α-keratin. The feature illustrates the difference between the tighter unions of protein chains giving a permanent framework, and the extreme mobility of chains in the rubberoid plastics, in the latter of which stretching enormously improves or indeed creates sufficient order to record as a fibre X-radiogram.

Striking inter- and intra-crystalline phenomena occur with increasing humidity. Meridian spacings are very slightly (less than 0·7 per cent), equatorials considerably (3–10 per cent), increased. This recalls comparable temperature phenomena with *n*-aliphatic long-chain compounds[13,14] and in itself resolves the direction of the axial covalent polypeptide chains from the looser cross-sectional links of ionic, S-S, H-bond, or van der Waals type. Differential lateral expansion with stretching, swelling, or temperature should facilitate crystallographic indexing. Though the variation with swelling is ample and apparently anisotropic, certain assignments have not yet been made because of the broad and composite nature of these reflexions, and the possibilities of other than simple crystallographic cell interpretations.

X-ray interpretation of fibrous protein structure can follow two lines: the broadly physico-chemical or the more rigorously crystallographic. With such data as those of Fig. 2, the second method becomes increasingly feasible, but special caution attends its use. Not only does lack of resolution occur in fibre X-radiograms of macro-units formed of protean chain systems, but also X-radiation and prolonged stretching permanently affect the keratin substance. There is the possibility of two or more phases, not necessarily of identical chemical composition, and that, indeed, to be inferred largely from data for assorted wools. Is the 'crystalline' phase a molecular lattice, or is it due to such parts of a chain system as can form local order through suitable chemical and spatial characteristics? Are reflexions all normal ones of a unit cell, or may a small number of large units per micelle dimension demand sub-indexing, as seems possible for viruses[15]? Is the diffuseness of certain groups of reflexions due to (*a*) thin or imperfect crystallites, (*b*) mere lack of resolution of overlapping spots, (*c*) the diffuse scattering of elastic, thermal, or Raman vibration systems, (*d*) a secondary structure of grids or layers with only average regularity and differing possibly in reflecting power? Are we dealing with a member of a structural series in which intramolecular residue or chain or grid interchange parallels the atomic or molecular replacements of alloys and solid solutions generally? Such possibilities, some readily dismissible, will be discussed elsewhere; it will be provisionally assumed that the recorded reflexions arise by Bragg scattering.

The sharp meridian (0*l*0) series are orders of a large unit of pattern along the fibre axis. This unit is either 658* or 198 A., the ratio being 10/3. Discrimination is not easy. The latter is a good fit for many full sequences, but lacks a second order, and, in particular, the sharp 5·14 A. spacing seems just too far out to fit. The fine structure of the strong 9·8 A. equatorial is too vague to distinguish between a second order of 198 and a sixth of 658. Fitting to 658 A. is good but less critical. But the number itself is significant. Accepting an approximate 100 per cent chain extension in passing from α- to β-keratin[3], it follows that three amino-acid residues occupy the length of 5·14 A. Thus 658 A. corresponds exactly to 384 (= $2^7 \times 3$) residues. To accord with present chemical analyses (for wool), a molecule would contain $2^8 \times 3^3$ residues, or a multiple thereof. The simple metrical relation of these Bergmann numbers is strongly suggestive. These are easily reconciled crystallographically even if a single chain is chemically representative. In fact, certain simple folds are found to give cell cross-sections that accord with much of the X-ray data, yield a cell containing 2^m3^n numbers of Svedberg units ($M \sim 17{,}500$), and are feasible on general grounds. Not only is this fibre periodicity significant, but the intensity distribution is also peculiar: the dominant meridian spacings and stronger layer line translations expressed as orders of 658 A. are also generally very closely of the form 2^m3^n (cf. Table 1). The order (2^7) of the very strong meridian contains the L.C.M. of the 2^m factors in the proportions of component residues (wool).

The 2^m3^n rule for dominant meridian orders holds best for the longer spacings. For spacings less than 4 A., thus approaching atomic bond distances, the fine structure of the polypeptide chain begins to be appreciable and introduces its own periodicities. Curiously, even the 2^m3^n rule scarcely discriminates for certain between the values 658 and 198 A. For

Table 1. Distribution of main reflexions along the fibre axis in X-radiogram of α-keratin (African porcupine quill tip).

Intensity (*I*)	Spacing (*D*)	Order of 658 A.	Nearest 2^m3^n
1. *All* meridians or very-near-meridians of $D \geqslant 5{\cdot}1$ A. with $I \geqslant w+$			
m	66·3 A.	10	9
m	*27·6	24	24
m	*19·95	33	32
wm	18·10	36	36
w+	13·11	50	48
m—	12·35	53	54
w+	10·44	63	64
m—	6·16	107	108
v.str.	5·14	128	128
2. Other dominant meridian reflexions			
m	4·45	(app.) 148	144
w—	4·00	,, 164	162
w—	3·42	,, 193	192
w+	3·08	,, 214	216
vw	2·55	,, 258	256
(?)	2·29	,, 287	288
m+	1·49	,, 442	432
3. Prominent non-axial spots or groups			
	* (appr.)	(appr.)	
vw	63	10½	—
vw	43	15	16
vw	23·8	27½	27
vw	17·6	38	36
m	14·5	45½	48
m+	13·3	49	48
vw	12·2	54	54
w	8·83	74½	72
w+	6·18	106½	108
wm	6·10	108	108
w+	5·71	116	—
m+	5·65	117	—
m-str.	5·12	128	128
w+	3·35	196	192
w	3·17	208	216

* Layer line translation.

The value 642 A. originally quoted[3] was referred to an *unstretched* spacing of 5·06 A. for the dominant meridian[3]; the new value, 5·14 A., should be more accurate.

certain higher orders (2^m3^{2+p}) of 658, this is necessarily so as $198/658 = 2^2/3^2$ to 1 per cent. As shown below, lower orders transfer to orders of 198 A. (to not more than 0·2 off integral) which do not differ from the 2^m3^n rule beyond 1 unit:

Order of 658 A. ..	10	24	33	36	53	63	107	(117)	128
Order of 198 A. ..	3	7	10	11	16	19	32	35	(38·4)

Explanations of periodicities and intensity distributions involving mainly 2's and 3's can be derived from (*a*) crystallographic symmetry operations on a unit of structure, (*b*) a material framework, possibly largely independent of local chemical composition, but involving 2's and 3's (for example, molecular ring or hexagon units), (*c*) *ad hoc* distributions of specific components.

The repeat unit along the fibre axis (if 658 A.) and the intensity distribution of its orders, taken in conjunction with the molecular proportions of the component amino-acids in (wool) keratin, suggests that *spatial distribution and not only relative amount* of the amino-acids is regular; the simplest model to explain it is a multiple-ladder structure, the analysis an extension of that of Shearer[18] for the simplest of long-chain polar molecules (*n*-aliphatic ketones). Consider the properties of an open-chain composite-ladder molecular keratin model, the main rib (polypeptide chain) having side-rungs (component amino-acid residues) distributed along its length, each regularly in its own period. Let the ladder-structure be a 2^M3^N number of residues long (X-rays and elastic properties) and the residues occur in $2^{-m}3^{-n}$ molecular proportions (chemical analysis). The number of a given residue per molecular length is $2^{M-m}3^{N-n}$. Neglecting fine structure of the chain itself, the structure factor of a cell containing one such model molecule is such that only for orders with k indices characteristically related to the particular $2^{M-m}3^{N-n}$ occurring are meridians of any intensity; further, not all these values need occur strongly. The orders appearing and their intensities depend on the scattering weights, periodicities, relative phases and average dispersion in the fibre axis direction, of the side-rung residues, and also on any regularly occurring chain configurational feature that does not conflict with the validity of the 2^m3^n relationship. For wool keratin the first four factors can be quite accurately estimated and a fitting sought for any postulated configurational chain feature.

Straightaway, the model needs progressive modification to accord with porcupine quill keratin. (Unfortunately, adequate chemical analyses are not yet available for porcupine quill itself, but the comparative data of Table 2 indicate that probably no serious error would be introduced by using the figures available for wool keratin.) First, a single-chain molecule shows 'clashes' in its subperiodicities; the model must then extend from chain to grid or scaffold. Again $M-m$, $N-n$ must be positive or zero. While the $2^7 \times 3$ and $2^8 \times 3^2$ data are subject to revision, $N-n = -1$: an adjustment with the effect of a triple long-range fold is required. Both corrections tend in the direction of a cell of probably large cross-section, as found. Further, symmetry operations, for example in a polymolecular cell, and certain regular short-range chain corrugations could affect the dominant periodicities, and the latter would also introduce additional weighting.

But most important of all to explain are the common broad structure and properties of the keratin-myosin series. The most probable interpretation would seem to be that chain periodicities, which in themselves do not account for the main similarities of the keratin-myosin series, must be superposed on some skeleton structure based on close-range chain folding for which the general evidence[1,2,3] is tremendously strong. Such folding would introduce additional weighting, though not necessarily different periodicities outside the 2^m3^n scheme. In fact, the new α-model does this. Astbury's original chemical

TABLE 2.

Muscle			Canad. porcupine quill			Wool[3] (Lincoln)			Mohair			
D	*I*[2]	Approx. order of 128 *D*[0][1]	*D*	*I*	Approx. order of 128 *D*[0]	*D*	*I*	Approx. order of 128 *D*[0]	*D*	*I*	Approx. order of 128 *D*[0]	Nearest $2^m \times 3^n$
A.			A.			A.			A.			
26·3	str.	25	27·5	m-str.	24				27·5	(m)	24	24
						24·6	m	27				27
			20·3	m	33	20·0	m	33	20·4	m	33	32
19·1	m	34½										36
						15·9	wm	42				—
13·82	wm	48	13·8	wm	48				13·7	m	49	48
			12·6	m+	53	12·7	wm	53				54
11·09	m-str.	59										—
			10·7	m	62	10·48	wm	63	10·65	w	63	64
9·22	m-str.	71				9·41	wm	71				72
7·95	wm	83	7·94	w+	83							81
			7·33	wm	91							—
6·89	wm	96	6·66	m—	100				6·67	w+	100	96
			6·27	m	106	6·28	m	106	6·24	w+	107	108
5·13[0]	str.	128	5·18[0]	str.	128	5·20[0]	str.	128	5·20[0]	str.	128	128
4·60	w+	143	4·47	w+	148							144
4·34	w+	151							4·42	w	150	—
4·10	w+	160 (110)*F*[1]				4·15	w	160 (110)*F*				162
						Unoxhletted wool			3·39	w	196	192
3·62	w	(200)*F*										—
2·89	w	(210)*F* or *C*[0]										—
2·46	vw	(020)*F*				2·55	w	(020)*F*				—

Horsehair			Horn			
63·5	w	10				9
27·5	w—	24				24
12·5	vw	53				54
6·10	vw	108				108
5·17[0]	m	128	5·15[0]	wm	128	128

Table References

1 128 *D*[0] taken as major period.
2 Very similar for Wensleydale.
3 Intensities: *w*, weak; *v*, very; *m*, medium; *str.*, strong.
[0][1] *F*, fat; *C*, collagen.

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structure[8] devised to explain the 5·1 A. meridian and the quantitative relations of the $\alpha \rightleftharpoons \beta$ transformation has been shown by Neurath[18] to leave too little room for certain side-chains. The new α-model has a simple structural basis, the *close-packing of side-chains*, which results in a square-stepped polypeptide chain of unit 5·1 A., thus yielding the strong meridian reflexion little dependent on side-chain weighting; that is, on *chemical composition as such*, but, of course, accounting only for the main X-ray features. This structure is stereochemically accurate and accords with many broad factors: a common principle for fibrous proteins, the right density for polymorphic transitions, a simple intramolecular stereoisomerism for the $\alpha \rightleftharpoons \beta$ transformation, correct distances for hydrogen bond backbone linkage between adjacent chains, and, of course, a close-packing of side-chains. In short, along the fibre axis we probably get a regularly *spaced* grating (period 5·1 A.) with its planes very regularly varying in reflecting intensity over a much larger (658 A.) period. A combination of this main structure and periodic fine structure to fit the experimental data is at present under investigation.

Provided the very regular porcupine quill fibre structure is not too disoriented by chemical treatment, the work of Speakman[17] on the chemistry of the cross-links in wool invites the possibility of so chemically weighting selected residues as to promise their location by comparative analysis of the varying intensity distribution in the (0ℓ0) meridian series. Experiments with heavy metal and other atoms are in progress.

The fine periodicity is necessarily in size and reflecting power a function of chemical composition. The inter-linking of the keratin-myosin series thus depends on the standard skeleton, with the side-chain positions as sites, or by interchange of chains or grids—an intramolecular parallel to solid solutions. Keeping in mind the chemical relationships[19], in X-radiograms of the series we would then expect: (*a*) a standard effect on the intensities imposed by the common configurational feature; (*b*) very similar fibre-axis periodicities (~ 658 A. as in quill); (*c*) the dominant (fairly large spacing) reflexions probably 2^m3^n orders of this; (*d*) the particular 2^m3^n orders similar for the keratin members, with slight intensity variation, but more markedly different for myosin.

This is largely borne out, as seen in Table 2, which gives some meridian reflexions obtained for various α-keratin types together with measurements of an earlier (Astbury) fibre X-radiogram of dried sartorius muscle (frog) at 50 per cent extension. Especially for the latter, precision is not sufficient to *determine* macroperiods, and the strong 5·1 A. lines are taken as the 128th order. Of the few reflexions that appear not to conform, three or four lines of a sharper nature in muscle (of which myosin is the principal constituent) are just those which clearly can be indexed as the chain cross-sectional reflexions of the fatty constituent or the prominent meridian arc associated with collagen.

Analysis proceeding will be reported elsewhere. What is important is that the keratin-myosin group of protein fibres is amenable even in detail to searching X-ray methods; that the new information already obtained for α-keratin shows suggestively simple regularities in accord with those from quite other sources; and that the results substantiate and can now check in detail the new α-model which reconciles the broadest of protein characteristics and, while specific enough for quantitative treatment, is simple and accommodating in detail, as, of course, the biogenesis of proteins demands.

This work is being carried out under the direction of Dr. W. T. Astbury in the Textile Physics Research Laboratories, and under the joint auspices of the International Wool Secretariat and Department of Textile Industries, University of Leeds, to all of whom the writer offers his most cordial thanks.

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THE ISLAND OF NEW GUINEA*

By L. Evelyn Cheesman

THIS huge tropical island is only partially explored. Even the coasts are not yet thoroughly and accurately charted, and though there are few large areas of the vast hinterland entirely unknown, only the main topographical features have been named and located in an approximate position. Early records, too, need to be checked; this was proved by one of the Papuan patrols, which found a large lake where the Arthur Gordon Range was supposed to be. The traveller is, therefore, always inadequately equipped for penetrating what is for the most part an exceptionally difficult type of country, whether it be mountains or swamps.

The early geological history of New Guinea can only be indefinitely conjectured since there has never been a general survey. Briefly, it can be summarized thus: Palæogeologists postulate a large land mass, which they named Palæonotis, as having extended from Asia to Australia during the Middle Cretaceous period, and extending as far as New Caledonia, and westward to Sumatra and Java. Some time during the Early Eocene, part of this land broke away from the Australian shelf and later submerged. From this submerged land mass the great folding movements of the Miocene-Pliocene periods raised the high central mountain system of New Guinea. During the next epoch connexion with the Philippines sank, and the island took form as we know it to-day. A more recent connexion with Australia is supposed to have taken place in the Late Pliocene, when the Torres Strait was dry for a relatively short period, allowing the marsupials and other Australian groups of plants and animals to migrate to New Guinea.

It would be thought that geologically young land

* Substance of a Friday discourse at the Royal Institution delivered on May 28.

raised from the sea, its sole continental connexion being with Australia, would possess a fauna and flora basically Australian; also that these would be incomplete with many gaps in the groups. On the contrary, New Guinea has continental fauna and flora, of Asiatic origin, with no serious gaps in the totality of groups such as to suggest population by temporary land bridges. The suggestion is rather that there was connexion with an older fully populated land. There is a strong Australian element, a Malaysian element, and a weak South American element which could have been introduced via Australia.

A possible explanation is to be found north of New Guinea, where are remnants of very ancient mountain ranges, some of pre-Cambrian rock, on an alignment parallel with that of the main ranges. These are: the west coast of New Britain, the Finisterre and Torricelli Ranges, Mt. Oinake, the Cyclops Range, Japen and Waigeu Islands. Supposing these to be part of an old land mass, populated from Asia, which remained above water long enough to colonize the young land of New Guinea as it rose from the sea, this would account satisfactorily for the origin of the Papuasian flora and fauna, which are characterized by a very rich neo-endemism, indicating isolation over a long period.

The Papuasian faunal sub-region includes adjacent archipelagos, the Solomons and New Hebrides archipelagos and New Caledonia.

It is interesting to note in connexion with the above that the Cyclops Range, of very ancient pre-Cambrian rock and old crystalline schists, shows no indication of submergence; no maritime deposits have ever been recorded from the mountains. Another interesting fact emerges from records by geologists of an Australian oil company working in this region for fifteen years, who found evidence of tectonic movements still proceeding in the Torricelli Range.

Reef limestone belonging to many periods and exhibiting an endless variety in formation occurs throughout New Guinea from the coast to high mountains. The formidable "limestone barrier", crossed by Karius and Champion in 1928 between the sources of the Fly and the Palmer Rivers, is described by them as consisting of series of pits of varying sizes, some as much as 100 ft. in circumference, with pinnacles and knife-edged ridges between them. What is probably a similar type of formation appears on Waigeu and also on Japen. On the former island, series of small narrow ranges of about a thousand feet in height have built up the eastern shore of Mayalibit Bay. Between these ranges are very deep clefts almost to sea-level, the ridges are castellated, of rough sharp-edged rocks, with deep pits between the peaks—most dangerous to negotiate especially when screened by vegetation.

Sea erosion produces curious three-sided cylindrical clefts in limestone cliffs, as on the north side of Oinake Massif on the boundary between Dutch and British Territories. One example on Djoea Bluff between 200 ft. and 300 ft. high pierces a cliff to the beach.

Volcanic intrusion occurred in the north of New Guinea; a few volcanoes are still active on the coast. In 1933 a violent earthquake wrecked the Torricelli Range. This ranks with the world's most severe earthquakes. So late as 1939 the northern slopes were still bare precipices, quite an arresting sight in that luxuriant forest; valleys were still choked with rocks, rivers were forming new channels, and huge tree trunks, still standing, have been split and twisted in a peculiar fashion as if wrenched by a giant fist.

There is not so much variation in temperature as might be expected; the thermometer registers 74°–84° F. up to an altitude of 3,000 ft. Above this the temperature falls a few degrees; 38° at night has been recorded at 10,000 ft. On the highest mountains, 16,000 ft., snow and frost occur. Carstenz Top, 15,709 ft., has large glaciers.

Rainfall is extremely heavy over nearly all the island, but varies very greatly in localities. There are two seasons marked by the north-west and south-east monsoons. Dry areas or savannahs with characteristic vegetation occur contiguous with high rain forest. They are accounted for by the alignment of mountain ranges. Where strong rain-laden winds blow parallel with ranges, areas on each side are drier, and where high mountains obstruct the passage of these winds, there is a very heavy rainfall. Thus, Port Moresby at the end of one savannah has an annual rainfall of 32 in., while the government station of Kikori at the farther end among high peaks has 232 in.

The savannahs are distinct from areas deforested by natives to make their villages, on which a secondary vegetation replaces the forest, principally of plants and trees of rapid growth, and species with a very wide distribution. There are many such areas, especially on mountains where a large native population has flourished, which has either died out or moved to another locality. Even the alpine grassland of high mountain tops where are no native villages is disturbed by human agency, being often partially destroyed by the fires of native hunters.

New Guinea is fortunately outside the cyclone zone, but is subject to very high winds, gales, squalls and cyclonic disturbances. In Papua occur sudden very violent squalls known as *gubas*. In Netherlands New Guinea in the first week of October, gales from the north-west called *wambrau* blow with terrific force for eight or ten days, after which they subside as suddenly as they began. It is an uneasy experience to be among the mountains during this period. Hundreds of trees are blown down; there is no adequate shelter from torrential rain except rock caves, for the rain is driven horizontally. Nothing can be seen but steamy white clouds being carried by with an amazing velocity, or the grey, driving sheets of rain. Coastal tribes recognize by certain signs, such as brilliant sunsets, the approach of the *wambrau*; canoes race to shelter and are drawn up on beaches. The south-east of New Guinea does not experience these gales, but apparently (according to verbal reports) they are felt at the same date north of the Papuan Gulf, and they probably blow across a wide zone of the centre of the island except where high mountain masses intervene.

The native population is Papuan-Melanesian, characterized by stiff, kinked hair, which gave them the early name of Papoo, that is, "fuzzywigs". Several influences can be detected which result in a considerable variation in build, skin colour, and facial features, as well as character of the hair, which is fine and straight or waved in true Melanesians and Malaysians. In some tribes the skin is definitely lighter in colour, with a bronze tint.

True pigmies exist, mainly in high mountain regions, where they are thought to have taken refuge from stronger, aggressive tribes. In certain districts are small Negritto-Papuans, resulting from some

crossing of types not clearly understood, and presenting variations in size of adults even in one family.

Within the last ten years, gold prospectors made discoveries of densely populated areas in the highlands of the Mandated Territory which had always been supposed to be sparsely inhabited. These tribes had evolved an extremely interesting and advanced type of agriculture.

Head-hunting and cannibalism certainly are still practised, but such customs are becoming rarer. As Papuans come in contact with more advanced peoples, public opinion among themselves is apt to change, and such barbarous practices are deprecated and will finally be voluntarily abandoned.

All Papuan tribes fall into two categories, they are either people of the forest or people of the sea. From babyhood they are taught to observe every landmark, changes in the sky with nuances of which we are scarcely conscious; all have distinctive names, as also all living things however small. Frequently there are different names for the two sexes, even of insects. Sea people are as unhappy when away from the coast and as terrified of mountains as forest people are unhappy in coastal areas and terrified of the sea.

With its rich tropical vegetation, New Guinea is surprisingly poor in natural products to support human life. The indigenous population flourishes only where animal or fish diets are plentiful. Some tribes appear under-nourished. Among vegetables cultivated in native gardens the introduced sweet potato is of good food value; the same cannot be said of other roots, taro and yam. Sweet potato alone can sustain white men in good health; this was proved by Champion and Anderson in the Bamu-Purari Patrol, 1936. Sago, which is the main food of many tribes, is not a white man's diet; it is indigestible and has no energizing value; this was proved by the Karius-Champion Patrol of 1928.

Papuans are extremely primitive, with a Stone Age mentality. Individuals exhibit a marked intelligence, but few outside influences appear to make lasting impressions. When working with white men, opportunities for mastering machinery or for learning store-keeping, mining, etc., may arouse latent ambitions, and the Papuan proves reliable and independent, although in most cases his acquirements are parrot-wise without undue reference to his reasoning powers. For the Papuan exists almost entirely subconsciously; his entire being is not only associated but also closely interlocked with all objects—human, superhuman, animate and inanimate—which compose his natural surroundings. His instinctive reactions to his outside world are scarcely comprehensible to those guided by reason; his power of self-suggestion is unbridled, so that death may be caused by a paroxysm of fear of something entirely imaginary. Control of his own vitality exists to an astounding degree. This mental attitude of Papuans must be realized by those who have any dealings with them, for thus many tragedies may be avoided. Belief in the supernatural is fundamental; it cannot be eradicated; and no other beliefs are sufficiently interesting and stimulating to be substitutes.

Scientific collections from New Guinea have been augmented of late years, due to the efforts of scientific societies and of individuals. Most valuable collections have reached the United States from the Richard Archbold Expeditions, particularly from the latest, 1937–38, when systematic collecting was carried out at different altitudes on the highest mountains of Netherlands New Guinea. A flying-boat is used as transport on these expeditions. Air transport is undoubtedly the solution to all difficulties of collecting on that island, and where the financial aspect need not be considered, should definitely be adopted.

NEWS and VIEWS

Royal Society of Arts: New President

DR. EDWARD FRANKLAND ARMSTRONG has been elected president of the Royal Society of Arts, of which he has acted for a number of years as treasurer. Dr. Armstrong is highly qualified to occupy this distinguished position, for he is a man who has not only made valuable contributions to scientific research in many fields of pure chemistry, both organic and physical, but has also held many high positions in the world of industrial chemistry, where his influence and guidance have led to important advances. As one of the small band of men who worked with the great van't Hoff during his sojourn in Berlin, Dr. Armstrong was successful in clearing up the phase transformations and equilibria of calcium sulphate and its hydrates, a problem which had greatly puzzled van't Hoff and some of his earlier collaborators.

During the period (1915–19) when Dr. Armstrong was managing director of Joseph Crosfield and Sons at Warrington, he carried out in collaboration with his chief chemist Hilditch (now Campbell Brown professor of industrial chemistry at the University of Liverpool) an important and pioneering series of researches on the catalytic hydrogenation of oils and fats. He has also done valuable original work in the field of carbohydrate chemistry, and is the author of well-known monographs on the simple carbohydrates and the glycosides. Apart from the numerous high industrial and administrative positions which he has held, his wide experience as president of the Society of Chemical Industry (1922–24), chairman of the British Association of Chemists (1926), chairman of the Association of British Chemical Manufacturers (1930–33), and chairman of the British Standards Institution (1934–35) will be of great value to the Royal Society of Arts.

Royal Society of Edinburgh: Honorary Fellows

THE following have been elected honorary fellows of the Royal Society of Edinburgh:

Foreign Fellows: Prof. G. D. Birkhoff, professor of mathematics, Harvard University; Dr. H. S. Gasser, director of the Rockefeller Institute, New York; Dr. D. Emilio Jimeno Gil, rector of the University of Barcelona; Prof. Thore G. Halle, Naturhistoriska Rikamuseum, Stockholm; Prof. H. S. Jennings, Walters professor of zoology and director of the

Zoological Laboratory, Johns Hopkins University; Prof. P. Karrer, professor of chemistry and director of the Chemical Institute, Zurich; Prof. O. Veblen, professor of mathematics at the Institute for Advanced Study, Princeton.

British Fellows: The Right Hon. J. C. Smuts, Prime Minister and Minister of External Affairs and Defence, South Africa; Prof. H. F. Baker, emeritus professor of geometry and astronomy in the University of Cambridge; Sir Joseph Barcroft, emeritus professor of physiology in the University of Cambridge; Sir Lawrence Bragg, Cavendish professor of experimental physics in the University of Cambridge.

University of Birmingham

AT the annual degree congregation of the University of Birmingham, the Chancellor (Viscount Cecil) conferred the honorary degree of doctor of laws on Dr. Benes, President of the Czechoslovak Republic, Mr. J. G. Winant, American Ambassador to Great Britain, Mr. R. G. Casey, Minister of State in the Middle East, Sir Edward Appleton, secretary of the Department of Scientific and Industrial Research, and Dr. H. R. Ricardo, a pioneer in the development of the high-speed internal combustion engine. In introducing Mr. Winant the Public Orator said: "What is clearest in these dubious times is that in international conflict his country and ours stand for the same things and stand or fall together. We shall not fall. This University has not fallen but is still working on, diminished but not brought low, making light of scars upon her buildings. Her desire is to see Americans and British continuing to work together, mix together, in time of peace as they are so freely doing in time of war, and from this hour to be mixed up herself, as inextricably as possible, with Mr. Winant, with the American universities and with the entire people of the United States".

Mr. Winant, in a short address, said: "We need opportunity for an education which includes understanding of one another if we are to be far-sighted and if we are to see friendly but distant lands. We have a shortage of teachers throughout the world to-day, and yet I believe we have new techniques which would help in that situation if we put our minds to it. The international picture language of Isotype and documentary films, the tactile aids to instruction, which have been evolved in the work of nursery schools, are examples. All of them have this in common: they operate through the medium of a common language, the language of eye and touch. Such new instruments of education—which may well mark an advance of human enlightenment without parallel since the invention of printing—are international in scope. Mass production can provide a system of education by the universal picture language of Isotype, or by the international picture language of the documentary film, at once attractive and, as such, capable of creating its own demand, suitable for use by people who speak different tongues, and equally adaptable to the re-education of those who have been indoctrinated with the Nazi virus and to our own needs, if we envisage the problem of re-educating Fascist youth as part of the wider problem of our common re-education to the tasks of the century of the common man. You can do a great service in Birmingham University to all mankind if you make these new tools available so that we can this time finish the job."

Ministry of Food: Cereals Research Station

THE Ministry of Food has, by arrangement with the Department of Scientific and Industrial Research and the flour milling industry, taken over for the period of the War the extensive laboratories at St. Albans which were previously occupied by the Research Association of British Flour Millers. The Ministry will have the advantage of the use of these laboratories and the existing staff for the consideration of all food research problems, but they will continue to be used in the main for specialized work connected with cereals and cereal products. The laboratories will, in future, be known as the Cereals Research Station of the Ministry of Food. Dr. P. Moran, who was previously director of research to the Research Association of British Flour Millers, has been acting as deputy scientific adviser to the Ministry since June 1940. In March last he was appointed, in addition, director of research in the Ministry of Food. In this latter capacity he will direct the work at St. Albans. From June 1, the date on which the transfer took place, the entire control and direction of the laboratories passed to the Ministry of Food.

The Solar Corona and Geomagnetism

THE recurrence of certain terrestrial magnetic storms at intervals of 27 days (the sun's rotation period) without any disturbance being visible on the sun's disk has long been an outstanding puzzle of solar physics. Observations of the chromosphere in monochromatic light have established a close connexion between the chromospheric eruptions responsible for short-wave radio fade-outs and certain of the great sporadic magnetic storms, which tend to occur about a day after the visible flare; but the recurrent storms seem as unconnected with chromospheric activity as with photospheric. A recent observation by Waldmeier (*Z. Astrophys.*, **21**, 275; 1942) throws light on this subject. By coronagraph observations at Arosa he has found that certain regions of the solar corona ("*C*-regions") exhibit temporary bursts of activity characterized by abnormally high intensity of the coronal line at 5303 A. The appearance of these areas at the sun's edge is often followed, or preceded, according as the region is being carried in front of or behind the disk by the solar rotation, by magnetic activity on the earth, the time interval being about 7 days (roughly a quarter period). The *C*-regions are very long-lived compared with chromospheric eruptions (at least 24 days as against about an hour). They are confined to the spot zones and seem to exhibit the 11-year periodicity in their frequency of occurrence. If further observations should confirm the connexion between magnetic storms and the central meridian passage of these active zones in the corona, it would seem that both *C*-regions and chromospheric eruptions must emit corpuscles, roughly radially and at speeds up to about 1,000 miles per second, throughout their life-times of the order of a month and an hour respectively.

Statistics of Public Opinion

PUBLIC opinion research may be considered to have started with Dr. Gallup, who predicted the voting in the presidential election in the United States of 1936 with an error of only 6½ per cent. For

later elections the error has been reduced to 2½ per cent. His method is to choose a sample of about 30,000, which is divided up for age, income, sex, and geographical location in the same proportions as the total population of the United States. Similar predictions are made for local elections in Great Britain by the British Institute of Public Opinion, using a sample of 1,500–2,000. The procedure seems very satisfactory for forecasting election results, but for estimating public opinion on such questions as confidence in the Government, statistical methods may be very misleading. In a paper entitled "The Limitations of Statistics in the Field of Public Opinion Research", read before the Manchester Statistical Society on April 14, Mr. J. G. Ferraby argues that for many purposes the qualitative methods adopted by Mass Observation are preferable. These rely largely on a panel of voluntary observers, who answer written questions drawn up by headquarters, keep diaries, forward letters received by them which comment on general topics, and report conversations, including some not intended to be overheard. It is claimed that this method subordinates accuracy of detail to accuracy in presenting a true picture of the whole. It is not explained how the accuracy of the observers or the truth of the picture is checked.

Earthquakes Registered at Kew and Stonyhurst

SEVEN strong earthquakes were registered at Kew Observatory during the month of May 1943. The first was on May 2, recorded at 01h. 10m. 17s. U.T., and has been reported as having been felt in Württemberg in Germany. The second, also on May 2, began recording at 17h. 30m. 11s. U.T. from an epicentre some 8,700 km. distant, and attained a maximum ground amplitude of 180 μ at Kew at 17h. 58m. 23s. U.T. The third, on May 3, began recording at 02h. 13m. 01s. U.T. from an epicentre some 11,000 km. distant, and attained a maximum ground amplitude at Kew of 200 μ at 03h. 03m. 15s. U.T. The fourth, not so large, was recorded at 09h. 15m. 54s. U.T. on May 20. and the fifth, on May 22, recorded at 22h. 10m. 37s. U.T., has been reported as having been felt in Italy. The sixth was by far the largest of the month. It was recorded at Kew at 23h. 21m. 54s. U.T. on May 25, and from the provisional interpretation of the record came from an epicentre some 12,500 km. distant. It attained maximum ground amplitude at Kew of 340 μ. At Stonyhurst the shock was also recorded at 23h. 21m. 54s. U.T. on May 25, and from a tentative interpretation of the record, came from an epicentre some 105° distant. The seventh earthquake was recorded at Kew at 00h. 27m. 01s. U.T. on May 28, and attained a maximum ground amplitude at Kew of 35 μ. It appeared to come from an epicentre somewhere near the one first recorded in the month. This shock was also recorded at Stonyhurst at approximately 00h. 28m. 20s. U.T. The German radio reported an earthquake at about this time, the epicentral region being west of Balingen near Stuttgart. Some roofs and chimneys are stated to have collapsed, causing injuries to people, and "strange glows" are reported to have been observed. The shock was also reported felt in Württemberg and Baden, in Oberade, the Bodensee and in Alsace. Tremors were felt in Switzerland, most strongly in the cantons of Schaffhausen and Thurgau. The earthquake was apparently preceded by a foreshock, which was felt at places in south-west Germany including Frankfort-on-Main; but this foreshock was not recorded with any intensity in England. The main shock was also recorded at West Bromwich, on the seismograph belonging to Mr. J. J. Shaw.

The Franklin Institute: Medal Awards

THE following medals of the Franklin Institute, Philadelphia, were awarded on April 21: *Franklin Medal and Honorary Membership* to Prof. Harold C. Urey, professor of chemistry in Columbia University, for his discovery and production of heavy hydrogen, which has proved of immense importance in furthering research in chemistry, physics, and biology; and to Dr. George Washington Pierce, for his development of "electrically squeezed" quartz crystals used to narrow the range of radio frequencies. The use of this principle in obtaining accurate oscillations has facilitated the construction of the most precise electric clocks. *Elliot Cresson Medal* to Prof. Charles M. Allen of Worcester Polytechnic Institute. His contribution to the field of hydraulics is a more rapid method of measuring the flow of water by adding a known amount of salt to the water and noting the time required for it to pass electrodes inserted in the pipe lines down-stream.

Howard A. Potts Medal to Dr. Don Francisco Ballen for restoring a valuable natural resource of his country to productivity; and to Dr. Paul R. Heyl of the National Bureau of Standards for his theoretically important formula to determine the constant of gravitation. *Frank P. Brown Medal* (for achievements in building and allied industries) posthumously to Mr. Albert Kahn, Detroit architect. *Edward Longstreth Medals* (jointly) to Mr. Robert Griffin De La Mater and Mr. William Schwemlein. Their design and successful application of a fluid brake has made practical the drilling of wells to great depths, with increased safety to life and property. *John Price Wetherill Medal* to Robert Howland Leach. *George R. Henderson Medal* to Harry Miller Pflager, senior vice-president of the General Steel Castings Company. *A Certificate of Merit* to Carl S. Hornberger. The 1943 *Louis Edward Levy Medal* (for the best paper published in the *Journal of the Franklin Institute* during 1942) to Anders Henrik Bull of Forest Hills, N.Y., for his paper, "Soil Pressure Distribution along Flexible Foundations".

Institution of Electrical Engineers

IN collaboration with the British Red Cross Society arrangements were made by the Institution of Electrical Engineers for British prisoners of war in Germany to sit for the associate membership examinations held in May and November, 1942. There were nineteen such candidates who took the examination, or parts thereof, on one or other of the two dates, seven of whom were successful in passing Parts I and II, three in passing Part I only, and one Part II only. Five others passed in single subjects, a special concession having been granted to prisoners of war to take one subject at a time if they so desired. A commendably high standard of marks was reached by the candidates. Seventeen candidates in Germany entered for the May 1943 examination.

ASLIB Training Course in Special Librarianship

OWING to the fact that many skilled and experienced librarians have been called up for various forms of national service, there is now great difficulty

in operating special libraries and information bureaux to the required standard of efficiency with the untrained and inexperienced assistant staff available. To meet this difficulty, the Association of Special Libraries and Information Bureaux (ASLIB) organized an emergency course of training during the spring of 1943. This has proved to be such a success that the course is being repeated in the autumn and, in addition, an intensive course is being given as a week's summer school (August 9–14) for those who, because of distance or other reasons, cannot attend weekly lectures. The fee for the course is five guineas. Applications to attend should be made as soon as possible to ASLIB, 31 Museum Street, London, W.C.1.

Summer School in X-Ray Crystallography

A SUMMER school in X-ray crystallography applied to industrial problems is being arranged by the Departments of Physics and of Mineralogy and Petrology in co-operation with the Board of Extra-mural Studies of the University of Cambridge, and will be under the direction of Dr. W. A. Wooster, University lecturer in the Department of Mineralogy and Petrology, and of Dr. H. Lipson, assistant in experimental research in crystallography. The number of practical applications of X-ray crystal analysis in industry has greatly increased, and it is quite probable that the usefulness of X-ray crystallography in the solution of industrial problems is not fully appreciated by technical men attached to industrial organizations. There is a growing need for the proper training of such technical men in this type of work, even though a working knowledge of it may have been acquired already. The chief aim of the summer school will be to give a training in the fundamentals of the subject, to bring workers into touch with the wide range of methods used, to teach them the newest techniques, and to indicate the many types of industrial problems in which this work can be used with advantage. Emphasis will be laid on practical work both with apparatus and in the interpretation of various kinds of X-ray photographs. The course is designed to extend from September 6 until September 18, but it will be possible to attend for either week only. In view of the present shortage of staff, apparatus and materials, the numbers attending the school will be limited; application to attend must be made before July 26. Further information can be obtained from the Secretary of the Board of Extra-mural Studies, Stuart House, Mill Lane, Cambridge.

University of London

THE title of professor emeritus of the history of medicine in the University of London has been conferred on Dr. Charles Singer on his retirement from the professorship of the history of medicine at University College.

The degree of D.Sc. has been conferred on Mr. F. R. Goss (Imperial College of Science and Technology); Mr. S. H. Harper (Imperial College of Science and Technology); Miss Emmy Klieneberger (Lister Institute of Preventive Medicine); Mr. W. T. Russell, a 'recognised teacher' at the London School of Hygiene and Tropical Medicine; Mr. T. E. Wallis, reader at the College of the Pharmaceutical Society, London.

Physical Society: Charles Chree Medallist

THE Charles Chree Medal and Prize are provided by the income from a fund given to the Physical Society in 1939 by Miss Jessie S. Chree, of Edinburgh, in memory of her brother, Dr. Charles Chree, a former president of the Society and superintendent of the Kew Magnetic Observatory. The Prize and Medal are awarded biennially in recognition of distinguished research in terrestrial magnetism, atmospheric electricity or cognate subjects, in which Dr. Chree was specially interested. The Council of the Society made the first award to Prof. Sydney Chapman in 1941 for his work in the first of these fields. The Medal and Prize for 1943 have been awarded to Prof. (now Brigadier) Basil F. J. Schonland, director of the Bernard Price Institute of Geophysics, Johannesburg, in recognition of his valuable researches in the second field (see NATURE, February 20, p. 218). The presentation will be made at a meeting of the Society at the Royal Institution on July 16, when Brigadier Schonland will deliver the second Charles Chree Lecture, taking as his subject "Thunderstorms and their Electrical Effects".

Announcements

IN accordance with the terms governing the appointment of the Parsons Memorial lecturers, the lecture for 1943 is to be given under the auspices of the Physical Society. It will be delivered early in the autumn by Lord Rayleigh. The date and further particulars will be announced in due course.

THE governing body of the Imperial College of Science and Technology has elected to Imperial College fellowships the following old students of the college: Dr. F. W. Lanchester, Dr. J. G. Lawn, Dr. F. C. Lea, Mr. F. Twyman, and Mr. H. G. Wells.

DR. R. R. MIMMS has been appointed lecturer in physics in the University of Birmingham to succeed Dr. Guy Barlow, who is retiring after forty years service. Dr. P. B. Moon has been given the title of reader in atomic physics.

THE University of Aberdeen has conferred the honorary degree of LL.D. on Prof. D. M. S. Watson, Jodrell professor of zoology and comparative anatomy, University College, London. The degree of D.Sc. has been awarded to W. Burns, for a thesis on "An Oscillographic Study of the Activity in Nerves associated with the Viscera"; and on Dr. R. D. Stuart, for a thesis on "A Study of Leptospirosis in the South-West of Scotland with special reference to Laboratory Investigation, Epidemiology and Specific Prophylaxis".

DR. W. E. LE B. DIAMOND, assistant secretary of the Institution of Gas Engineers since 1937, has been appointed general manager of the British Plastics Federation.

APPLICATIONS for the conditions of the competition for the Jones-Bateman Cup offered triennially for original research in fruit culture which has added to our knowledge of cultivation, genetics, or other relative matters, may be had on application to the Secretary, Royal Horticultural Society, Vincent Square, Westminster, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Biological Research in the West Indies

AT present, considerable interest is being evinced about development of the Colonies of the British Empire, particularly the West Indies. Plans have been, and probably still are being, made for utilizing the resources of the West Indies.

In 1939 I had the privilege of leading a strong scientific expedition to Jamaica and I returned with an idea which was shelved with the advent of war. In view, however, of the active developments now taking place, it would seem a proper moment to translate the idea into words. The Imperial College of Tropical Agriculture in Trinidad provides all that is required for training purposes in agriculture, forestry and animal husbandry, but the College is not intended to provide extensive facilities for general research in pure botany and zoology. A marine station exists in Bermuda, but it has, I believe, been closed for some years. In addition, there is the Carnegie marine station in the Tortugas, and a station under the control of Harvard University in the Panama zone.

The West Indies in peace-time are about our most accessible sub-tropical Colony, with a good service of boats and an excellent climate. The building of a tropical research station in this part of the globe would seem to be long overdue. At present most of the research work is being carried out by scientific workers from American universities, and while it may be agreed that the Caribbean is more truly their province, nevertheless the British West Indies look to Great Britain as their fountain-head. The present position, therefore, has many features which are to be deplored; but I believe that they could easily be rectified.

The proposed scheme envisages the building of a tropical research station in Jamaica, which it is hoped would be financed and controlled by a joint committee drawn from the staffs of British universities. The essential part of the scheme is the provision of special facilities and courses for undergraduates from any of the British universities. These courses would have to take place during the long vacations. It is hoped that shipping companies would provide concessions for such parties of students. Arrangements could also be made for members of the permanent staff to exchange for a year with biological lecturers from contributing universities, to the mutual advantage, it is hoped, of both. The station would have to combine research with teaching, and the staff would therefore be under an obligation to assist any of the West Indian schools. Courses comparable to those at Plymouth, Port Erin, Millport, would be arranged for senior schoolchildren during the shorter holidays at Christmas and Easter.

The research programme of the station would deliberately avoid problems in agriculture or animal husbandry, though it would certainly include fishery problems. The staff would be expected to devote themselves to research in pure botany and zoology: numerous problems are available in both these subjects. The proposed station could be described most satisfactorily as a combination of the marine laboratory at Plymouth and the botanical research station at Buitenzorg.

In order to provide the fullest possible scope both for research and teaching, it is suggested that the station be built in two parts, one part up in the Blue Mountains, perhaps on the disused site of the Cinchona station, or in the gardens at Castleton, while the other part would probably be best sited at Montego Bay or on the Pallisadoes. The mountain station would be under the control of a botanist and the lower one under the control of a zoologist. The distribution of staff might be arranged in the following manner:

Mountain station: Botanical director, entomologist, zoologist (reptiles and amphibians) and geneticist.

Lower station: Zoological director, oceanographer, algologist, marine zoologist and fishery expert.

In addition, there might be a floating staff consisting of a geologist, ecologist, mycologist, plant systematist, physiologist and experimental zoologist who would work at either station depending on their current problems. The number of these required would depend upon the scientific interests of the two directors.

It would be desirable for the Hope and Castleton gardens to come under the control of the botanical director, subject to the approval of the Government of Jamaica.

It is fully realized that this scheme is ambitious, and even if it is approved and started the complete staff might not be available for some time. In extenuation it may be pleaded that boldness at the outset is more likely to secure ultimate success. It might prove desirable that the Government of Jamaica, acting directly or indirectly, should contribute financially, but a fundamental part of the scheme is control by the British universities committee. Further discussion might indicate a desire from some of the Canadian universities to co-operate, and there are other details that remain to be worked out. The station is not intended to be a small technical university, nor is it meant to compete in any way with the Imperial College of Tropical Agriculture in Trinidad. A close liaison would inevitably exist between the station and the Institute of Jamaica.

The provision of such a station would give a great stimulus for research in the Caribbean and also at the same time an opportunity for future generations of scientific workers from the British Isles, Canada and the West Indies, to obtain at first hand knowledge of plants and animals which at present can only be provided by text-books.

Universities and Government are unlikely to approve finance for such a scheme at present, but if approval in principle is now given the details could be worked out and erection of the station could commence at the first favourable moment.

Broompark,
Oban, Argyll. V. J. CHAPMAN.

Ribonucleic Acids in Animal Tissues

THE original view that ribonucleic acids (yeast nucleic acid, phytonucleic acid) are to be found exclusively in plant tissues, and desoxyribonucleic acid (thymonucleic acid, animal nucleic acid) exclusively in animal tissues is now known to be no longer tenable.

Apart from the ribose mononucleotides and dinucleotides which are known to play an important part in the metabolism of animal cells, ribopolynucleotides (nucleic acids) have been detected histochemically in animal tissues[1], and one such ribo-

nucleic acid has been isolated from mammalian pancreas[3]. Moreover, desoxyribonucleic acid has been reported in yeast cells[3] and in plant tissues[4]. Both types of nucleic acid are present in bacteria[5].

Evidence is accumulating that both in the plant cell[6] and in animal cells[7] desoxyribonucleic acids are to be found in the nucleus and ribonucleic acids mainly in the cytoplasm. Ribonucleic acids may also form, especially in active cells, a small proportion of the nucleic acid of the nucleus[8] where thymonucleoprotein associated with the structure of the chromosomes predominates[9]. The nucleolus is composed of ribonucleoproteins[10] and is claimed to be associated actively with the synthesis of the cytoplasmic ribonucleic acids or nucleotides which are especially abundant at the nuclear membrane. These ribonucleic acids may also form part of the mitochondria[11], which appear to be phospholipid-ribonucleoprotein complexes. Such complexes of phospholipid with nucleoprotein containing ribonucleic acid are found in adult liver[11], in normal embryonic tissue[12], in embryo and adult brain[13], in equine encephalomyelitis virus[14] and in the active fraction of tumour-producing sarcoma extracts[15].

The biological activity of the ribonucleic acids has also been emphasized by their presence in plant viruses such as tobacco mosaic virus[16] and in the tissue growth-promoting factor of embryo juice[17], and by recent reports of high concentrations of ribonucleotides in the cytoplasm of cells in which rapid protein synthesis is taking place[18], including embryonic tissues, in tumour tissues[18], in the cytoplasm of proliferating and differentiating cells exposed to X- and gamma-radiation[19], and in the intercellular fluids from injured cells[20].

We have recently demonstrated, using chiefly tissues from the adult and embryo sheep, that ribonucleic acids (ribopolynucleotides) are widely distributed in surprisingly high concentrations in mammalian tissues. After removal of lipoid and acid-soluble phosphorus (including simple nucleotides), the tissue residue was extracted with cold and then hot 10 per cent sodium chloride to remove the nucleic acids, which were then precipitated as lanthanum salts and the precipitate analysed for pentose and desoxypentose. As evidence based on pentose estimations alone may not be in itself conclusive, the occurrence of ribonucleic acids has been confirmed enzymatically by treating portions of the sodium chloride extract with crystalline ribonuclease[21], which attacks ribonucleic acids only, and estimating the amount of nucleic acid phosphorus split off by the enzyme.

As the accompanying table shows, in most cases the total nucleic acid content, as measured by nucleoprotein phosphorus estimations, is considerably higher in the embryo than in corresponding adult tissues. The ratio of ribonucleic acid phosphorus to desoxyribonucleic acid phosphorus is, however, either of the same order in the embryo as in the adult or is slightly higher in the adult. Although the absolute amount, therefore, of both types of nucleic acid is much higher in most embryonic tissues than in the corresponding adult tissues, in any given tissue the amount of ribonucleic acid relative to the amount of thymonucleic acid remains the same in the adult as in the embryo or may be slightly greater in the adult.

The results also support the view that desoxyribonucleic acids are found in the nuclei and ribonucleic acids mainly in the cytoplasm. The ratio is very low (0·18) in the case of the isolated nuclei of embryo liver. Moreover, saline extracts of minced sheep embryo with powerful growth-promoting properties to fibroblasts cultivated *in vitro* have a much higher ratio (9·1) than any of the individual tissues. Such extracts would be expected to contain cytoplasmic rather than nuclear material[7]. This high ratio may throw light on Fischer's[17] claim that the growth-promoting activity of embryo juice is associated with the ribonucleoprotein fraction.

COMPARISON OF TISSUES OF ADULT SHEEP AND 9–10 WEEK SHEEP EMBRYO.

Tissue	Nucleoprotein phosphorus % dry wt.		Ratio ribonucleic acid phosphorus / desoxyribonucleic acid phosphorus in precipitate of La salts	
	Adult	Embryo	Adult	Embryo
Liver	0·25	0·55	3·5	2·5
Lung	0·43	0·76	0·9	0·7
Gut	0·52	0·68	1·0	1·1
Heart	0·12	0·49	2·8	2·8
Spleen	0·60	0·64	0·5	0·6
Kidney (cortex)	0·34	0·65	1·9	1·0
Brain	0·19	0·24	2·1	2·3
Muscle	0·09	0·36	3·6	1·4
Testis	0·42	—	2·6	—
Thyroid	0·10	0·42	2·0	1·1
Thymus	—	1·06	—	0·2
Pancreas (ox)	—	—	8·0	—

The evidence so far obtained indicates that animal tissues in general contain appreciable amounts of pentose nucleic acid (presumably ribonucleic acid) which can act as substrate for the enzyme ribonuclease. Whether its structure is similar to that of the ribonucleic acid of yeast, or more probably to that of the ribonucleic acid of the pancreas, is not yet known.

Our grateful thanks are due to Dr. Kunitz for a specimen of crystalline ribonuclease, and to the Carnegie Trust and the Medical Research Council for grants.

Physiology Department, University of Aberdeen. June 9.

J. N. DAVIDSON.
C. WAYMOUTH.

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Inhibition of Urease Activity by Ascorbic Acid

ASCORBIC acid has been found to have a marked inhibitory effect on urease activity. With some preparations of the enzyme, the formation of ammonia from urea is completely inhibited by a concentration of one part ascorbic acid in 200,000, and 50 per cent inhibition is obtained with one part ascorbic acid per million. The inhibition is prevented by addition of cysteine.

The urease preparation used was obtained by shaking 0·2 gm. Arlco-Jack bean meal with 18 ml. distilled water and centrifuging. 0·5 ml. of the urease, 3 c.c. acetate buffer *p*H 5·0, ascorbic acid and cysteine hydrochloride added as 0·1 per cent solutions, and water to make a volume of 8·3 ml. were kept at 45° C. for half an hour, and then 1·7 ml. of 3 per cent urea solution added, to give a total volume of 10 ml. The ammonia formed was estimated colorimetrically with Nessler's reagent, using a Hilger 'Spekker' photo-electric absorptiometer.

EFFECT OF ASCORBIC ACID ON UREASE ACTIVITY.

Ascorbic acid	Concentration of ascorbic acid	Ammonia formed, in 60 minutes
0·0 (Control)	—	13·4 mgm.
1·0 mgm.	1 in 10,000	0·0 ,,
0·1 ,,	1 ,, 100,000	0·0 ,,
0·05 ,,	1 ,, 200,000	0·0 ,,
0·02 ,,	1 ,, 500,000	3·2 ,,
0·01 ,,	1 ,, 1,000,000	6·2 ,,

EFFECT OF CYSTEINE AND ASCORBIC ACID ON UREASE ACTIVITY

Ascorbic acid	Cysteine hydrochloride	Ammonia formed in 60 minutes
0 (Control)	0·0 mgm.	10·9 mgm.
0	2·0 ,,	10·9 ,,
1 mgm.	0·0 ,,	0·0 ,,
1 ,,	2·0 ,,	13·3 ,,
1 ,,	1·0 ,,	11·5 ,,
1 ,,	0·5 ,,	10·9 ,,
1 ,,	0·2 ,,	7·2 ,,
1 ,,	0·1 ,,	6·9 ,,
1 ,,	0·05 ,,	2·3 ,,
1 ,,	0·01 ,,	1·7 ,,

My thanks are due to I.C.I. (Dyestuffs), Ltd., for permission to publish this letter.

L. A. ELSON.

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June 4.

Mechanism of Polysaccharide Production from Sucrose

IT has been shown that suitable bacterial cell extracts may act on sucrose with formation of a polyglucoside, dextran[1,2], or of a polyfructoside, levan[3]. As instances of enzyme-mediated polymer syntheses *in vitro*, these reactions command wider interest than would necessarily alone be merited by the functional importance of levan and dextran in microbe and plant metabolism. The enzymes responsible for production of levan and dextran from sucrose will conveniently be designated, in accordance with the substrate requirement and reaction end-product of the enzyme agent employed, respectively as levansucrase and dextransucrase. It is the former enzyme, as it appears in autolysate fluid of a selected Aerobacter strain[3], which is the subject of the present communication.

Levansucrase acts on sucrose or raffinose with production of levan and reducing sugar. All other substrates so far tested, including, in addition to common hexoses and disaccharides, several substrates with a terminal fructofuranoside group, namely, Neuberg ester, Harden-Young ester, methyl gamma fructoside, and inulin, failed to support levan production[4].

In its general properties, levansucrase is not unlike an ordinary carbohydrase. Its solutions are stable for months if kept on ice; when boiled they are immediately inactivated. The enzyme shows optimal activity at *p*H 5·5. It develops half-maximum synthesis velocity on sucrose concentrations between 0·02 and 0·06 molarity, the exact point depending on the enzyme lot. Glucose retards levan production to an extent dependent on its concentration relative to sucrose; fructose, on the other hand, is completely non-retarding. Dialysis of the enzyme does not affect its activity as measured in citrate buffer on sucrose.

It has been shown that levan production from sucrose and raffinose can be described by a common formula:

$$(n + m).\text{aldosido} <> \text{fructofuranoside} + n.H_2O \rightarrow (m+n).\text{aldose} + n.\text{fructopyranose} + [\text{levan}] \quad . \; . \; (1)$$

where aldose is either glucose or melibiose, depending on whether sucrose or raffinose is the substrate employed, m and n are whole numbers experimentally determined, and where [levan] represents m residues of fructofuranose polymerized to molecules of levan.

Galactose is not liberated by the enzyme from raffinose concomitantly with levan production. As is implicit in (1), therefore, production of levan from raffinose cannot be regarded as proceeding via intermediately formed sucrose.

The ratio m/n characterizes the synthesizing efficiency of sucrose conversion by the tested enzyme system. Its magnitude varied, depending on the conditions of the experiment and on enzyme lot, between 0·7 and 1·6.

Levan production does not proceed unchecked in the direction indicated in (1). After an initial rapid advance, it is progressively slowed. On adequate sucrose amounts, and using cell-free soluble levansucrase as synthesizing agent, levan production always came to a stop once the concentration of levan was between 300 and 500 mgm. per cent, the value being variable within these limits with enzyme lot. New simultaneous addition of enzyme and sucrose to mixtures in which levan production had come to a stop failed to renew the synthetic process.

It should be observed that the measured end-point is not one of mass equilibrium between the saccharide reactants noted. Increase in the initial concentration of sucrose beyond a necessary minimum does not bring about a shift in the position of the levan end-point. Moreover, reversal of the direction of the enzyme's activity has not so far proved feasible. Although intact cells of the selected Aerobacter strain are themselves able to ferment levan slowly, soluble cell-free levansucrase preparations failed completely to act either on levan alone or on mixtures of levan and glucose in any chemically evident way.

Balance sheet experiments revealed no drop in

total carbohydrate content during levan production *in vitro*. Furthermore, known poisons of respiration or of glycolysis, namely, cyanide, fluoride, monoiodoacetate, and phloridzin, failed to suppress or even markedly to retard levan production. One may conclude, therefore, that equation (1) states fully the *net* result of the action of Aerobacter autolysate on sucrose. Conceivably, levan production is linked energetically or otherwise with sucrose hydrolysis, from which, indeed, it has not yet proved separable. Clearly, however, it is not so linked with energy-yielding desmolytic transformations of sugar.

In conclusion, it is relevant to emphasize that the specificity characteristics of levansucrase, as reported above, run counter to the theory of levan production advanced by Hibbert and his school[4]. They fail, in fact, to conform, as will be detailed elsewhere, with any one of the established general systems of carbohydrase specificity[5].

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April 12.

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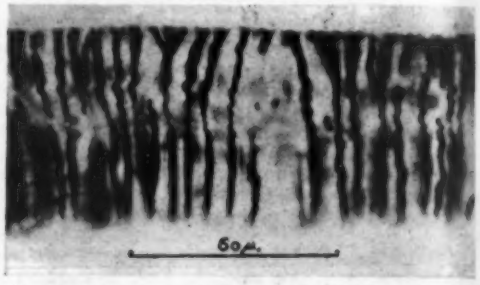
Pore Canals of the Insect Cuticle

IT has been suggested from time to time that the pore canals of the insect cuticle offer an important channel for the entry of contact insecticides, and Wigglesworth[1], working on the bug Rhodnius, in which the canals contain protoplasmic filaments, or perhaps fluid, has recently given additional evidence in favour of this view. But Richards and Anderson[2], as a result of their electron microscope studies of the cockroach cuticle, believe that the pore canals are filled by a watery fluid and not by protoplasm, and that oil-borne insecticides cannot penetrate by this route. Among earlier writers Holmgren[3], Plotnikow[4], and Berlese[5] have expressed the view that although the canals are occupied by protoplasm during early growth of the cuticle, they are later filled by some cuticular substance. If this is so, they would appear scarcely likely to be involved in insecticide penetration.

Although Wigglesworth[6] has rightly pointed out the slender basis on which the theory of cuticularization of pore canal contents rests, consisting of nothing more than the staining of the contents with such dyes as eosin and Congo red, and has shown that on drying the cuticle of Rhodnius the canals become filled with air, I have recently, during a study of the cuticle of Dipterous larvæ, had evidence that in some insects at least pore canals may be transformed into solid structures.

The third-stage larva of *Sarcophaga faloulata* possesses pore canals which on account of their large size are readily observed. In an early larva of this stage, they extend completely through the thin (10 μ) endocuticle. They show the tufted form illustrated by Plotnikow[4] for the canals of the caterpillar of *Bombyx mori* and of a Syrphid larva, and stain readily with eosin. In a larva one day older, the canals appear single and almost straight, with no terminal branching, and pass through only about the inner one-third of the now thicker (35 μ) endocuticle. Still later, no structures staining with eosin can be detected in the endocuticle, but in their stead rod-like bodies with no different staining reaction from the now very thick (60–140 μ) endocuticle are faintly visible.

It seemed probable that these rods are cuticular structures derived from the cytoplasm of the pore canals, and accordingly larvæ of progressively increasing age were heated with caustic potash, sectioned, and treated with iodine as a specific test for chitin in the manner described by Campbell[7]. In the early larva, in which the tufted pore canals stain with eosin, *no positive reaction took place*. In larvæ one day older, only the outermost parts of the canals assumed a deep violet, while in the still older larvæ, in which no structures are revealed by eosin, the whole extent of the canal assumed a deep violet coloration, deeper than that of the surrounding endocuticle, and even more indicative of the presence of chitin. The form of the pore canals was thus clearly revealed, as shown in the accompanying photograph.



SECTION THROUGH THE CUTICLE OF THE THIRD-STAGE LARVA OF SARCOPHAGA, TREATED WITH CAUSTIC POTASH AND IODINE TO DEMONSTRATE THE DISTRIBUTION OF CHITIN. THE PORE CANALS GIVE AN INTENSE POSITIVE REACTION.

It appears then that, although chitinization of pore canal contents may take place in some insect cuticles, those who accepted the coloration of the canals with eosin and similar stains as evidence of this were in error. Chitinization of the contents of the canals takes place later than in the stage illustrated by Plotnikow[4], and proceeds inwards from the distal ends of the canals. Whether it takes place by secretion of chitin from the tips of the receding protoplasmic filaments, or by bodily conversion of the filament itself, is not clear.

Further evidence of the solidity of the contents of the canals is provided by splitting the cuticle horizontally into two sheets, when the chitinous strands are clearly visible as solid rods projecting from the inner face of the outer sheet.

The form of the chitinized pore canals is similar to that of the open canals of the cockroach described by Richards and Anderson[2], but differs in showing terminal splitting—a result of the form of the canals of the early larva. In the photograph many of the canals appear unduly thick owing to the tight coiling of the helix. Some fifty to seventy canals are associated with each hypodermal cell, giving a density of distribution of the order of 15,000 per sq. mm. The smaller canals of the cockroach are much more numerous, occurring at the rate of 1,200,000 per sq. mm.

In connexion with the penetration of insecticides

through the cuticle, one point remains to be mentioned. The ease with which the contents of the canals are revealed by splitting the cuticle indicates that there is no fusion between them and the surrounding endocuticle; indeed there may exist around each filament a small annular space which might well be involved in insecticide penetration.

In conclusion, it should be stated that the cuticle of the Cyclorrhaphous third larval instar is probably specialized in connexion with its ultimate conversion into the puparium, and that chitinization of pore canal contents may not be of widespread occurrence. Nevertheless, a renewed examination of the cuticles of a number of diverse insects would be of interest.

A full account of the work of which these results form a part will be given later.

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June 11.

[1] Wigglesworth, V. B., *Bull. Ent. Res.*, **33**, 205 (1942).
[2] Richards, A., and Anderson, T. F., *J. Morph.*, **71**, 135 (1942).
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[5] Berlese, A., "Gli Insetti", vol. 1 (Milan, 1909).
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The Term *Tractellum* in Flagellate Organisms

IN the latest number of the *New Phytologist* an article appears under the heading of "Recent Work on Flagellar Movement", by D. Barker of the Department of Zoology and Comparative Anatomy, Oxford[1].

Though there is considerable difference of opinion apparently on the structure of flagella or cilia there is now no difference of opinion on one fundamental point, and that is that the waves or disturbances start at the base of the flagellum and not at the tip. This being so there can be no such thing as a tractellum. The whole misconception originated so far as I can gather with the flagellum of *Peranema trichophora* (Ehrbg.) Stein, as described and figured by Verworn[2].

Direct photographic evidence, taken from the high-speed cinema film, that the waves start at the base of the flagellum of Peranema and not at the tip was given in NATURE so long ago as 1936[3]. We know that in all cilia lining epithelial structures so far investigated, and also in the frontal and abfrontal cilia or flagella on the gills of Mytilus or Modiolus, the waves start at the base, and the same is true for all sponges so far as we know. Finally, the same has been shown to be true for more than a dozen different species of flagellates, and there is no direct evidence of it starting from the distal end.

It seems, therefore, highly desirous that the term *tractellum* should disappear from all text-books, elementary or otherwise, until direct photographic evidence of its existence is produced.

In the majority of flagellates the flagellum or flagella are attached to the anterior end of the cell, but to use an apt expression of a colleague, the organism is not *pulled forward by its hair but it is pushed forward by its nose.*

Actually the anterior end of the cell is pushed round by the flagellum and the whole cell thus made to rotate and gyrate about a given axis, and this of itself is sufficient to supply a forward component on the simple mechanical principle of the inclined plane.

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[1] Barker, D., *New Phyt.*, **42**, No. 1, 49 (1943).
[2] Verworn, M., *Pflugers Archiv.*, **46**, 149 (1890).
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How the Sperm Reaches the Archegonium in *Pellia epiphylla*

IN text-books on botany *Pellia epiphylla* (L.) Corda is very often chosen as an example of the liverworts, and hence any information about its structure and biology is of interest. It has no doubt been chosen because it has, in comparison with the majority of liverworts, a relatively massive gametophyte and a large sporophyte; it is also a widely distributed and common plant.

It is usually assumed that the sperm swims by means of its two flagella from the antheridium to the archegonium, which contains the ovum. The archegonia are, however, placed at the apex of the plant and the nearest antheridia are 5–10 mm. distant on the dorsal surface. Showalter has shown that free sperms in a closely related genus (Aneura) may take several hours to spread a distance of 10 mm. In previous investigations[1] it was found that in many mosses and liverworts it was the spermatocytes, each of which contains a single sperm enclosed in a membrane, which were liberated from the antheridia, and that these were carried rapidly by the agency of surface tension over the free water surface at a rate of about 20 mm. per minute.

In June 1943 plants with ripe antheridia were taken and their upper surfaces wetted. The spermatocytes were seen to be extruded in grey masses into the water, and when these reached the surface their spermatocytes were seen to break apart and disperse over the wet surface with great rapidity. The spermatocytes reached the archegonial involucre in about fifteen seconds. It takes about fifteen minutes for the free, swimming sperm to emerge from the spermatocyte, so that from the time of opening of the antheridium only a little more than fifteen minutes would elapse before free, swimming sperms were at the archegonia. If the transport of a sperm from an antheridium to an archegonium depended on its swimming powers alone, it would take several hours for it to reach the archegonium, and in that time the wet surface of the thallus might become dry.

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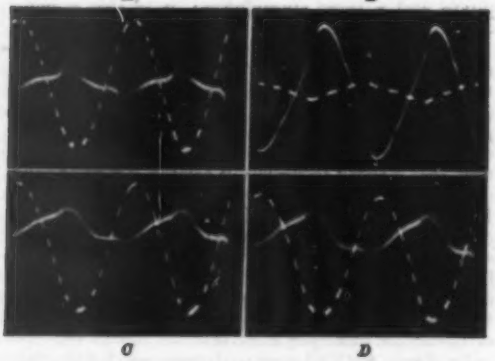
A New Method of Electrical Testing, Applied to Insulated Wires

A DIFFICULTY was experienced recently in carrying out some electrical tests on enamelled wires at temperatures up to about 120° C. Pairs of wires were twisted together in accordance with B.S.

Specification 156, Appendix A, and although it was possible to obtain all the required electrical properties at atmospheric temperatures, this was not so with some classes of enamel when the same tests were attempted in rising temperatures. As changes in power factor were being followed, a relatively high voltage between wires was used (about 1·2 kV.), and it was found impossible to avoid premature breakdown of some classes of enamel when the temperature was raised rapidly. Evidently a means of controlling the voltage applied between wires was wanted so that as the temperature rose, the voltage would fall off; but it was not practicable to do this accurately and quickly enough with ordinary hand control.

Automatic voltage control was satisfactorily achieved by replacing the test transformer then in use by another having an extremely poor regulation. By this means the enamels which had hitherto broken down prematurely caused an increasing drain on the transformer as the temperature rose, this being followed concurrently by a drop in voltage.



By connecting voltage and current leads to a double-beam cathode ray oscillograph with the usual 180° phase shift, it was thus possible to follow changes in power factor with changes of temperature as rapid as 100° C. per second, the required voltage regulation being entirely automatic. Oscillograms *A* and *B* represent conditions at 20° C. and 120° C. respectively, using an enamel sensitive to temperature; *C* and *D* are those for an enamel which shows little sensitivity to temperature. For clarity all voltage curves are shown dotted, and the interchange of current and voltage magnitudes in the former case is thus shown very clearly. The 'haze' at the peaks of the current wave in oscillogram *A* depicts a high-frequency discharge consequent upon the high voltage used, and this is naturally absent in oscillogram *B*, which illustrates a much lower voltage. This high-frequency discharge appears to be a characteristic of those enamels which are sensitive to temperature.

The change from condition *A* to condition *B* is not a chemical one, and on the oscillograph the gradual change from one extreme to the other could be observed any number of times as the temperature was raised and lowered.

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Biological Control of the Fly Population in Sewage Filters

IN his communication on "Town Planning and the Small Sewage Purification Plant", Dr. Lloyd[1] discusses the problem of controlling the numbers of the sewage fly, *Anisopus fenestralis*, in and around sewage filters close to housing estates. Though Psychoda flies were also present in large numbers in these filters, they apparently caused little nuisance compared with that from the Anisopus flies, which entered the neighbouring dwellings in large numbers.

For the past two years observations have been made, as part of the programme of the Water Pollution Research Board of the Department of Scientific and Industrial Research, of the seasonal variation in the fly population in large-scale percolating filters at the Minworth works of the Birmingham Tame and Rea District Drainage Board. The results suggest a possible answer to the question raised by Dr. Lloyd.

The four filters under observation at Minworth have a varied fauna composed mainly of *Psychoda alternata*, *Anisopus fenestralis*, *Achorutes viaticus*, and Enchytræid worms. It was found that under optimum conditions of growth, *Anisopus fenestralis* took 121, 73, 50 and 39 days at 9° C., 13° C., 18·5° C. and 21° C. respectively to complete its life-cycle. With a restricted food supply, however, the duration of the life-cycle may be much longer than is indicated by these figures. Whereas *Psychoda alternata* is restricted to the warmer months[2], the temperature of the filters is normally favourable throughout the year for the development of Anisopus. The filters therefore carry during the winter months a large potential population of flies which emerge in the spring if weather conditions and conditions in the filters are favourable. If the surface layers of the filters are open, Anisopus emerges in large numbers during periods of warm weather in the spring. The numbers decline in the late spring and early summer, when *Psychoda alternata* begins to breed in large numbers in the filters.

At summer temperatures it appears that *Psychoda alternata* is more effective than Anisopus as a scouring organism. Under certain conditions the accumulation of solid matter in the upper layers of a filter may be sufficient in amount to prevent the emergence of Anisopus without impairing the efficiency of the filter by causing serious ponding on the surface. Such conditions may prevail in the spring in filters operated at high rates as alternating double filters with a short period of alternation, or in a filter treating a mixture of sewage and effluent at a high rate. The emergence of large numbers of Anisopus in the spring is thus prevented. The filters at Minworth became cleared of solid matter by summer owing to the scouring activity of Psychoda. Numerous Psychoda but few Anisopus emerged from these filters during the summer.

The successful competition of Psychoda with Anisopus in these filters is a good example of natural biological control, and the observations recorded suggest another line of approach to the problem raised by Dr. Lloyd, which is consistent with the operation of filters at their maximum capacity.

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TREATMENT OF CANCER BY FAST NEUTRONS

By DR. L. H. GRAY
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STONE AND LARKIN[1] have recently reported upon their experience, over a period of two years, in the treatment by fast neutrons of 120 patients with advanced 'incurable' cancer in various sites. The neutrons were generated by the 60 in. cyclotron at the Crocker Radiation Laboratory, San Francisco. They were able to demonstrate both clinically and pathologically that some tumours disappeared as a result of neutron therapy, and their report, which is presented with admirable clarity and restraint, is on the whole encouraging. We wish to comment upon the possible influence of the energy of individual neutrons, both incident and at a depth in the body, on the results obtained.

It has now been established beyond all doubt that the biological effect produced by ionizing radiations depends not only on the total ionization produced within the cell (the tissue dose) but also on the spatial distribution of these ions. The latter parameter may be expressed numerically by the average number of ions formed per micron of track of the ionizing particles within the cell, and varies from 10 in the case of γ-rays to 40 for 200 kV. X-rays, about 500 for neutrons (see below), up to 4,000 for α-particles. (The mean density of ionization along the track of a uranium 'fission' fragment is about 130,000; but the biological effects of these particles have not so far been studied, though such experiments seem feasible in certain cases.)

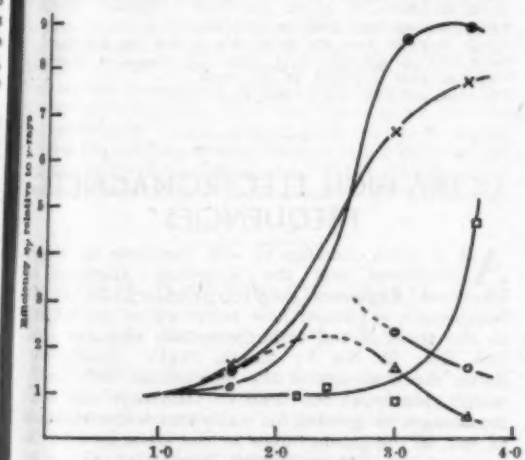

Fig. 1. BIOLOGICAL EFFICIENCY AS A FUNCTION OF $\log_{10}$ (ION DENSITY).

□ Disinfection of spores of *B. mesentericus* (ref. 9).
○, × Two types of chromatid injury induced in the microspores of *Tradescantia bracteata* by irradiating during prophase. ○ Simple chromatid breaks. × Isochromatid breaks (ref. 14 and unpublished data obtained by Kotval, and Kotval and Gray).
△ Inhibition of mitosis in roots of *Vicia Faba* (Gray, Mottram, and Read, unpublished.)
● Lethal effect on roots of *Vicia Faba* (ref. 18).

Most of the determinations of η are subject to an uncertainty of the order of 10–20 per cent.

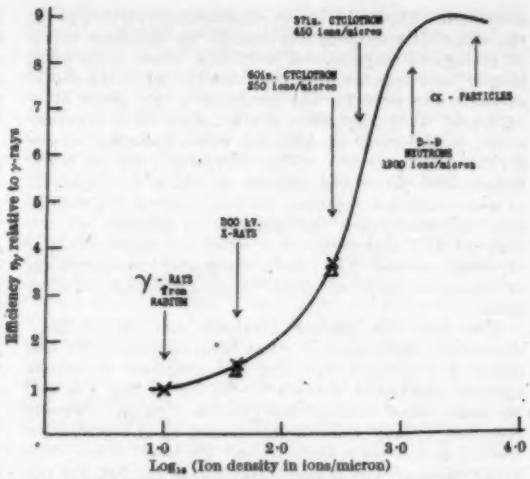

Fig. 2. EXAMPLE OF BIOLOGICAL EFFICIENCY AS A FUNCTION OF $\log_{10}$ (ION DENSITY).

Full Curve: Lethal action on roots of *Vicia Faba* (Fig. 1 and ref. 18).
Experimental points:
× Skin reaction
$\eta_{\gamma}^{X} = 1{\cdot}5$ (ref. 24); $\eta_{X}^{N} = 2{\cdot}5$ (refs. 1, 22)
△ Lethal action on tumour tissue irradiated *in vitro*
$\eta_{\gamma}^{X} = 1{\cdot}3$ (ref. 23); $\eta_{X}^{N} = 2{\cdot}6$ (refs. 19, 22)

We may express the relative efficiency of two radiations A and B in producing a given biological reaction by the reciprocal ratio of the doses necessary to produce this effect and denote it by the symbol η_{B}^{A}. (Where published data refer to doses not measured in units proportional to the ionization per unit volume of the cell, allowance has been made for this fact in calculating efficiencies. It has been assumed that 1 *n* unit = 2·5 energy units[22].) It has been shown that in the case of the production of sex-linked lethal mutations in Drosophila sperm[2,3], the inactivation of a number of viruses[4–7] (under conditions which preclude an indirect action through the ionization of the aqueous medium) and the disinfection of vegetative bacteria (*B. coli*)[8,9], η decreases with increasing ion density. This decrease is capable of a simple quantitative interpretation in terms of the relation between the size of the structure inactivated and the mean distance apart of the ions[5]. On the other hand, there are many cases in which, over the range of ion density investigated, which in some cases is 10–500 ions/micron, and in others 10–4,000 ions/micron, η increases steadily with ion density. These include the production of chromosome aberrations[10–13], the inhibition of hatching of Drosophila eggs[14], the lethal effect on roots and shoots of seedlings[16,17,18], the inhibition of growth of inoculated mouse tumours irradiated *in vitro*[19], the regression of mouse tumours irradiated *in vivo*[20], and numerous other reactions listed elsewhere[21,22].

Fig. 1 shows five examples of the variation of biological efficiency with ion density, of the type under consideration. They have been chosen as being cases in which the same biological material and the same criteria of effect have been employed in irradiations covering the whole range of available ion

densities. There is clearly considerable diversity in the effect of changing ion density on different types of biological response—a diversity which goes even deeper than appears from these curves, since the shape of the curve even for the production of a given type of injury in a particular entity, such as a chromosome, is different at different developmental stages in the cell cycle[10–13]. This diversity may at some future time prove valuable as an aid to the analysis of some complex reaction, such as tumour regression, into its constituent factors, but at present we are only at the threshold of a coherent interpretation of these curves. The recent successful interpretation of chromosome break data[14] may provide a starting point.

The data for tumour response are rather fragmentary. The value of η has been measured for the effect of γ-rays, X-rays and fast neutrons on mouse tumour irradiated *in vitro*[12,15,23]. From Fig. 2 it will be seen that within this limited range, tumour response closely follows the course of the curve for the lethal effect on bean roots. Further, it has been found that η_γ^N has a very large value ($\sim$ 20) for the effect of (D–D) neutrons on mouse tumour irradiated *in vivo*[20]. The bean root curve (Fig. 2) may therefore be taken as a rough guide to the probable influence of ion density on tumour response. The mean ion densities of the recoil proton tracks from neutrons generated in several ways are indicated on the figure. It is clear that these neutron beams may be expected to differ considerably in biological efficiency.

The successful treatment of a tumour does not depend on a single biological effect, but on at least two effects, the tumour reaction and the normal tissue reaction, and possibly on others.

Stone and Larkin[1] formed an estimate of the relative effectiveness of neutrons and X-rays for one important normal tissue reaction, namely, the production of a given degree of erythema of the skin. The corresponding value of η has been plotted and lies close to the same curve (Fig. 2). It is interesting to note also that they observed less severe skin reactions than expected when changing from treatment with the 37-in. to the 60-in. cyclotron, but the possibility that the difference lay in the method of dose measurement could not be excluded. Any superiority of neutrons over X-rays, however, may be taken to indicate that η is increasing more rapidly with ion density for the tumour than for normal tissue, and therefore in the light of Fig. 2 we may hazard a guess that if neutrons from the 60-in. cyclotron showed *some* superiority over X-rays, neutrons from the 37-in. cyclotron or (D–D) neutrons would show an even greater superiority. If it is desirable to retain the advantage of the high neutron intensity obtainable from the larger cyclotrons, it might be found to be of therapeutic value to slow down the neutrons somewhat by passage through wax before entering the body.

The optimum neutron energy can, of course, only be found empirically. There is no reason for believing that it will coincide with the neutron energy for which η is maximum for the lethal effect on bean roots. Indeed, should the course of the curve for $\frac{\eta \text{ (tumour)}}{\eta \text{ (normal tissue)}}$ have the shape of Fig. 1, one would probably choose to use neutrons somewhat faster than (D–D) neutrons, so that, as a result of the slowing down of the neutrons in passing through the body, an energy corresponding to the maximum value of this ratio is just reached at the site of the tumour. In this way, for equal physical doses, the skin would be less damaged because exposed to a radiation of relatively lower efficiency, and at the same time the tissues deeper than the tumour would not be excessively exposed.

When a 60-in. cyclotron is used as a source of neutrons, it is likely that the skin is in a relatively favourable position, being exposed to very fast neutrons, and that the tissues deeper than the tumour, through being exposed to slower neutrons, are relatively more damaged (for equal doses) than the normal tissue at the site of the tumour. This may perhaps be the reason why Stone and Larkin observed very severe systemic reactions and diarrhœa in patients receiving radiation to the upper abdomen, though the skin, which received a very much larger dose (ionization per unit volume of tissue), was not excessively damaged.

[1] Stone and Larkin, *Rad.*, **39**, 608 (1942).
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[3] Dempster, *Proc. U.S. Nat. Acad. Sci.*, **27**, 249 (1941).
[4] Wollman, Holweck and Luria, NATURE, **145**, 935 (1940).
[5] Lea, NATURE, **146**, 137 (1940).
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[20] Gray, Mottram and Read (unpublished).
[21] Gray, Mottram, Read and Spear, *Brit. J. Rad.*, **13**, 371 (1940).
[22] Aebersold and Lawrence, J. H., *Amer. Rev. Physiol.*, **4**, 25 (1942).
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ULTRA-HIGH ELECTROMAGNETIC FREQUENCIES

AT a joint meeting of the Institute of Radio Engineers and the American Institute of Electrical Engineers held on January 28, G. C. Southworth explained how micro-waves are adding to the tools of the communications engineer (*Bell Lab. Rec.*, 21, No. 7; March, 1943). Briefly outlining the conquest of the frequencies, Dr. Southworth mentioned the need of television and communication in general for more and wider channels as one of the prime forces in the advance into the micro-waves. Other desirable features of the 'micro' region are the small size of antennæ and their high directivity, and the fact that the waves follow the line of sight and thus do not interfere with signals beyond their own useful range.

Some method of conducting waves from generator to antenna, and from antenna to receiver, is obviously necessary. While ordinary insulated wires can be used through the broadcast range and beyond, in the short-wave range special attention must be given to losses in the insulation, to radiation into space and into nearby conductors, and to the effects on

tuning produced by stray capacitance and inductance. The coaxial line, in which one conductor is formed into a tube and the other is enclosed in it, is an excellent expedient. If the central conductor is completely removed, it is still possible to transmit energy down the tube, which then becomes a wave guide. If the tube is filled with insulating material, even the outer conductor can be removed. The coaxial and the conducting tube or wave guide are the most promising of these arrangements. Compared from the point of view of attenuation losses, the coaxial line is better at the lower frequencies; but in the micro-wave region, which is of most importance at the moment, the wave guide has decided advantages. However, below a certain frequency—about 3×10^9 for the wave guide—the wave guide 'cuts off' abruptly.

Wave guides are decidedly useful for conveying micro-waves from their generator to the place where they will be used. They contain no insulating material and so are entirely immune to moisture, while their waves can be radiated by simply flaring out the tube into a horn. A wave guide may also be made into a resonant chamber by blocking one end with a metal plate and closing the other partially by a plate with a hole in it. By varying the length of the chamber, it can be tuned to the precise frequency desired; with a small hole, if the chamber is $\frac{1}{2}$, 1 or $1\frac{1}{2}$ of a wave-length, it will admit energy readily; if $\frac{1}{2}$, $\frac{3}{4}$ or $1\frac{1}{4}$ wave-lengths, it will repel energy, that is, be anti-resonant. Since the wave pattern in a resonator is fixed, it is possible to locate a detector at precisely the right spot in the pattern in order to obtain maximum response.

Somewhere along the frequency scale in the neighbourhood of a billion cycles per second—wave-length about one foot—micro-wave technique undergoes a marked change. Methods using the conventional go-and-return-conductor type of circuit give way to the somewhat simpler hollow pipe, or wave guide, circuit. These newer methods seem to be at their best in the centimetre wave-length range. At the longer wave-lengths, the component parts become inconveniently large. For shorter waves, it would appear that ability to manufacture small parts would become an important limitation. What the technique will be beyond this point is a matter for the future.

THE INSECTS OF GUAM

By DR. A. D. IMMS, F.R.S.

A KNOWLEDGE of the insect fauna of small but important islands is very desirable before such fauna is inevitably changed by the operations of man and species have become extinct. In certain cases this must have happened even before some animals were discovered, as in Hawaii, for example.

The island of Guam is very isolated in the waters of the Pacific Ocean and measures nearly 30 miles long and 4–8 miles wide. A rainfall of about 90 inches per annum is usual and mostly during July–November. The northern half of the island is an elevated limestone plateau originally covered with tropical jungle, of which much still remains. Areas with sufficient soil are occupied by gardens and small farms, and there are a few small settlements. The southern half of the island includes a low volcanic range of mountains near the western shore, the highest peak being 1,334 ft. Streams on the eastern slope are the larger, and at the mouths of the valleys are located coastal villages. Much of the farming is carried on in the valleys, especially rice culture. On the plateau region are some cattle ranches. Rice is the only irrigated crop: not enough is grown to supply all needs and in 1936 importations were made from Japan. Other crops are corn, copra and many kinds of fruits and vegetables.

The foregoing remarks are mainly taken from an account entitled "Insects of Guam I.", which forms Bulletin 172 of the Bernice P. Bishop Museum, Honolulu (1942). This account is made up of some twenty-seven articles by specialists on different groups of insects, and presents the results of studies made on material collected during an entomological survey of the island in 1936. The survey was conducted under the auspices of the Hawaiian Sugar Planters' Association for the purpose of studying insects of economic importance in Guam. This island is the most important station between the Philippines and Honolulu on the route of Pan-Pacific Airways. Unknown insects were already being found in planes arriving in the Hawaiian Islands, and notwithstanding precautions by fumigation of aircraft, an occasional insect was found which had not fully succumbed. There is concern lest unknown pests, injurious to sugar cane or other Hawaiian crops, might gain an entry and become established in the archipelago. It is noteworthy in this connexion that about fifty species of pests of cultivated plants are known in Guam which are not known in Hawaii. The Sugar Planters' Association has always adopted a broad-minded and scientific policy, and it recognizes that among these insects of Guam are no doubt many that would become pests should they reach the Hawaiian Islands and become established therein. Furthermore, the insect fauna of the island is very inadequately known.

Among the various groups of insects dealt with in this bulletin no discrimination is made of those of economic importance—all come in for discussion and description of their species where necessary. It is noted that eleven species of dragonflies and twenty-two species of Thysanoptera but only three species of Aphididæ and a single species of Aleurodidæ are recorded. Butterflies number fourteen species, which is in contrast to the whole Hawaiian Archipelago, which only supports ten species. The Guam butterflies are mostly immigrants, possibly some of recent arrival, as only three or four species had been previously recorded. The most notable are the 'Monarch' *Danaida plexippus* and *Hypolimnas bolina*, the latter being widely distributed in countries and islands in and bordering the Pacific Ocean. Moths are not included in this volume except the Sphingidæ, which number five species, including the cosmopolitan *Herse convolvuli*. Of the Coleoptera the Curculionidæ, with forty-nine species, head the list; among them no fewer than thirty-three species and eight genera are described as being new. Among Hymenoptera twenty-nine species of ants and ten species of wasps are enumerated. Of the ants nine of the species have been already recorded from the Hawaiian Islands. Only a few Diptera are included in this volume: they comprise, among others, five species of mosquitoes, including the notorious *Aedes ægypti*. A second volume of the survey, dealing with other groups of insects, is promised at a later date when these studies have been completed.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, July 10

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Open Discussion on Industrial Radiology.

Sunday, July 11

ASSOCIATION OF SCIENTIFIC WORKERS (at Birkbeck College, London, E.C.4), at 7 p.m.—Meeting to discuss British Science in the Allied War Effort and to exchange greetings with Soviet men of science meeting in Moscow. Speakers: Prof. J. D. Bernal, F.R.S., J. G. Crowther, Prof. S. A. Sarkisov, and Sir Alfred Webb-Johnson.*

Monday, July 12

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Institution of Structural Engineers, 11 Upper Belgrave Street, S.W.1.), at 7.15 p.m.—M. Frantisek Nemec, Minister of Industry and Commerce and of Economic Reconstruction to the Czechoslovak Government: "Economical and Technical Reconstruction in Central Europe".

Tuesday, July 13

QUEKETT MICROSCOPICAL CLUB (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 7.30 p.m.—Dr. J. R. Baker: "The History of Microscopical Staining Technique".

Thursday, July 15

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Edward Mellanby, K.C.B., F.R.S.: "Nutrition in Relation to Bone-growth and the Nervous System" (Croonian Lecture).

Friday, July 16

PHYSICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 5 p.m.—Brigadier Basil F. J. Schonland, O.B.E., F.R.S.: "Thunderstorms and Their Electrical Effects" (Charles Chree Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER in Education and in the Training Department of University College, Cardiff, with special qualifications in science, preferably physics and chemistry—The Registrar (July 16).

LECTURER IN PHYSICS at the Polytechnic, Regent Street, London, W.1—The Director of Education at the Polytechnic, stamped addressed foolscap envelope for application form (July 19).

LECTURER in FERROUS METALLURGY at the Chesterfield Technical College—The Clerk to the Governors (July 23).

ASSISTANT SECRETARY—The Secretary, Institution of Gas Engineers, 1 Grosvenor Place, London, S.W.1 (July 26).

THE JOHNSTON CHAIR OF BIOCHEMISTRY in the University of Liverpool—The Registrar (July 31).

DEMONSTRATOR IN ANATOMY (MALE OR FEMALE) in the University of Sheffield—The Registrar (August 2).

ASSISTANT WORKS MANAGER, METAL AND STEEL FACTORY (Government of India)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Reference ON.F.607), Alexandra House, Kingsway, London, W.C.2.

CHIEF METALLURGIST FOR FERROUS AND NON-FERROUS WORK AT METAL AND STEEL FACTORY, Ishapore (Government of India)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register (Reference ON.F.1002), Alexandra House, Kingsway, London, W.C.2.

SECRETARY of the Institution of Professional Civil Servants—The Honorary Secretary of the Institution, 17 Hans Place, London, S.W.1.

LECTURER IN PHYSICS AND PURE AND APPLIED MATHEMATICS at the Neath Mining and Technical Institute, Glamorgan.—The Principal.

TEACHER OF MATHEMATICS AND SCIENCE in the Junior Technical School, North-East Essex Technical College and School of Art, Colchester—The Clerk to the Governors.

LECTURER IN HORTICULTURE at Bishop Otter College (Women Teachers' Training College) at the Old Palace, Bromley, Kent—The Principal.

REPORTS and other PUBLICATIONS

(not included in the monthly lists: Supplement)

Great Britain and Ireland

Burton-on-Trent Natural History and Archæological Society. Local Records for 1942. Presented by H. J. Wain. Pp. 27. (Burton-on-Trent: Natural History and Archæological Society. The Museum.) 1s. [36

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation, submitted to the Twenty-second Annual General Meeting on June 1st, 1943. Pp. ii+16. (London: Empire Cotton Growing Corporation.) [36

Institution of Electrical Engineers. The Organisation of Post-War Electrical Research. Pp. ii+6. (London: Institution of Electrical Engineers.) [36

Institute of Physics. The Education and Training of Physicists. Pp. 8. (Reading: Institute of Physics, The University.) [36

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 11: On an Epidemic of *Gibberella saubinetii* (Mont.) Sacc. on Wheat in Eire in 1942. By Dr. Robert McKay. Pp. 111–129+plates 4–5. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.). 2s. [36

Association of Special Libraries and Information Bureaux. Report of Proceedings of the Seventeenth Conference held at the Royal Society, London, November 7th and 8th, 1942. Pp. 72. (London: Association of Special Libraries and Information Bureaux.) 3s.; to non-Members, 6s. [36

Institute of Welding. The Production of Single Spot Welds in Mild Steel Plates of ⅛", ¼" and ⅜" Thickness. By J. Dearden and Dr. Hugh O'Neill. Pp. 16. (London: Institute of Welding.) 2s. [36

Annual Report of the Zoological Society of Scotland for the Year ending 31st March, 1943. Pp. 22. (Edinburgh: Zoological Society of Scotland.) [36

Institution of Gas Engineers. Communication No. 257: 86th Annual Report and Accounts for the Year 1942. Pp. 32. Communication No. 258: Presidential Address. By E. V. Evans. Pp. 32. Communication No. 259: The Gas Industry—Considerations on Further Development. Pp. 66. (London: Institution of Gas Engineers.) [36

Forestry Commission. Post-War Forest Policy. Report by H.M. Forestry Commissioners. (Cmd. 6447.) Pp. 114. (London: H.M. Stationery Office.) 2s. net. [106

Ministry of Fuel and Power: Committee on the Efficient Use of Fuel. Fuel Efficiency Bulletin No. 18: The Sensible Use of Latent Heat, Part 1. Pp. 12. (London: Ministry of Fuel and Power.) [156

Labour Conditions in Ceylon, Mauritius and Malaya. Report by Major G. St. J. Orde Browne. (Cmd. 6423.) Pp. 114. (London: H.M. Stationery Office.) 2s. net. [176

The Organisation of Post-War Electrical Research. Pp. ii+6. (London: Institution of Electrical Engineers.) [226

Other Countries

Proceedings of the United States National Museum. Vol. 93, No. 3165: New Genera and Species of Bark Beetles of the Subfamily Micracinae (Scolytidae, Coleoptera). By M. W. Blackman. Pp. 341–366+plates 29–30. (Washington, D.C.: Government Printing Office.) [36

Indian Central Cotton Committee: Technological Laboratory, Technological Bulletin, Series A, No. 55: Technological Reports of Trade Varieties of Indian Cottons, 1942. By Dr. Nazir Ahmad. Pp. vi+106. 1.8 rupees. Technological Bulletin, Series A, No. 56: Technological Reports on Standard Indian Cottons, 1942. By Dr. Nazir Ahmad. Pp. iv+106. 1.8 rupees. (Bombay: Indian Central Cotton Committee.) [106

University of Pennsylvania. Hall Effect and Conductivity of Cuprous Oxide. A Dissertation in Physics presented to the Faculty of the Grade School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By Stephen James Angello. Pp. 5 (Philadelphia: University of Pennsylvania.) [106

Indian Forest Bulletin No. 114: A Note on the Treatment of Green *Hollong* (*Dipterocarpus macrocarpus*) Sleepers. By D. Narayanamurti. Pp. iii+12+3 plates. 4 annas; 6d. Indian Forest Bulletin No. 115: How to Distinguish between the Sapwood and Heartwood of *Sal* (*Shorea robusta*). By Dr. K. Ahmad Chowdhury. Pp. iii+6+3 plates. 4 annas; 6d. (Dehra Dun: Forest Research Institute.) [106

Indian Forest Leaflet No. 33: Detailed Design of Timber Roof Trusses made with Wooden Disc Dowel Joints. By V. D. Limaye. Pp. ii+13+2 plates. 4 annas; 6d. Indian Forest Leaflet No. 34: Types of Timber Seasoning Kilns suitable for Drying Indian Woods. By M. A. Rehman. (I. F. Leaflet No. 11, revised.) Pp. iii+7+1 plate. 4 annas; 6d. (Dehra Dun: Forest Research Institute.) [106

Indian Forest Bulletin No. 113: Interim Report on the relation between Rate of Growth and Strength of Natural and Plantation Teak. By V. D. Limaye. Pp. 14. (Delhi: Manager of Publications. 7 annas; 8d. [156

Indian Forest Records (New Series). Silviculture, Vol. 4A, No. 3: Standard and Commercial Volume Tables for Teak (*Tectona grandis* Linn. F.) in the Central Provinces. By Bakhshi Sant Ram. Pp. v+145–170+3 plates. (Delhi: Manager of Publications.) 2.4 rupees. 3s. 9d. [156

Annual Report of the Imperial Council of Agricultural Research, 1941–42. Pp. v+130. (Delhi: Manager of Publications.) 4.10 rupees. 7s. 3d. [156

Fouad I University: Faculty of Science. Special Report, 1942. Pp. 129. (Cairo: Fouad I University.) [156

Occasional Papers of the California Academy of Sciences. No. 20: Early Naturalists in the Far West. By Roland H. Alden and John D. Iliff. Pp. iv+59. (San Francisco: California Academy of Sciences.) 1 dollar. [216

Transactions of the American Philosophical Society. New Series, Vol. 32, Part 3: Research on Early Man in Burma. By Hellmut de Terra and Hallam L. Movius, Jr. With Supplementary Reports upon the Pleistocene Vertebrates and Molluska of the Region, by Edwin H. Colbert and J. Bequaert; and Pleistocene Geology and Early Man in Java, by Hellmut de Terra. Pp. vi+265–464+35 plates. (Philadelphia: American Philosophical Society.) 3 dollars. [226

Catalogues

Sotheran's Price Current of Literature, No. 871: Annotated Catalogue of Works on Exact Science. Pp. 88. (London: Henry Sotheran Ltd.)

Photography as an Aid to Scientific Work. Seventh edition. Pp. 16. (Ilford: Ilford, Ltd.)